

0097/I

PAINT AND SURFACE PREPARATION

TRAINING PROGRAM FOR SHIPYARD PERSONNEL

A project of the National Shipbuilding Research Program

**U. S. Department of Commerce
Maritime Administration
in cooperation with
Avondale Shipyards, Inc.**

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[Instructor's Manual]

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Instructor's Guide

FOREWORD

This manual is written for the use of shipyard painting and coating supervisors/trainers who have responsibility for improving the skills of today's blasters and painters. Every effort has been made to avoid unnecessary theoretical descriptions and the technical language of corrosion engineers and paint chemists. The material is presented in a straightforward manner reflecting the practical realities of shipyard painting practices.

Because painting practices and department organization vary among the shipyards, the manual presents a reasonably complete overview of commonly accepted marine painting and surface preparation techniques. It is expected that each supervisor/trainer will adjust the material to suit the ship, equipment, and level of crew in his charge. The planning notes offered at the beginning of each unit will assist in preparing each session. As the supervisor/trainer becomes more experienced using the manual, he may wish to add his own slides and discussion examples drawn from the experience of his yard.

The use of protective coatings is the principal means of providing interior and exterior metal corrosion protection. Well aware of the upgrading effects on job quality which can be obtained by proper training and informal inspection, the Society of Naval Architects and Marine Engineers (SNAME) 023-1 Surface Preparation and Coating Committee conceived the training program of which this manual is a part.

The project was carried out under the National Shipbuilding Research Program, in cooperation with Avondale Shipyards, Inc., Mr. John W. Peart, Program Manager. Development work was accomplished under subcontract to the Institute of Applied Technology (IAT), Washington, D.C., Mr. Jay I. Leanse, Executive Director and Ms. Jess Gersky, Project Director. IAT staff, Ms. Jean Kaplan and Ms. Karen Seeborn, were responsible for the research, writing, and editing of the text and visual materials.

The authors wish to express their appreciation to the many individuals and companies who contributed their time and practical knowledge in the development of this training program. We wish to acknowledge the advice and technical support of the SNAME 023-1 Committee, Mr. C. J. Starkenburg, Chairman, and Mr. Jack Garvey and Mr. Robert Schaffran of the Maritime Administration and those individuals who reviewed and commented on the text in its draft form: Mr. Dean M. Berger, Gilbert/Commonwealth Associates; Mr. David T. Bloodgood, Bethlehem Steel Corporation; Mr. Walter Dany, Binks Manufacturing Company; Mr. Benjamin S. Fultz, Offshore Power Systems, Inc.; Mr. Daniel Krogh, Clemco Industries; Mr. Walter H. Radut, Exxon International Company; Mr. Frank H. Rack, Shipbuilding Consultants, Inc.; and Mr. Walter MacDonald, FMC Corporation, Marine & Rail Equipment Division.

EXECUTIVE SUMMARY

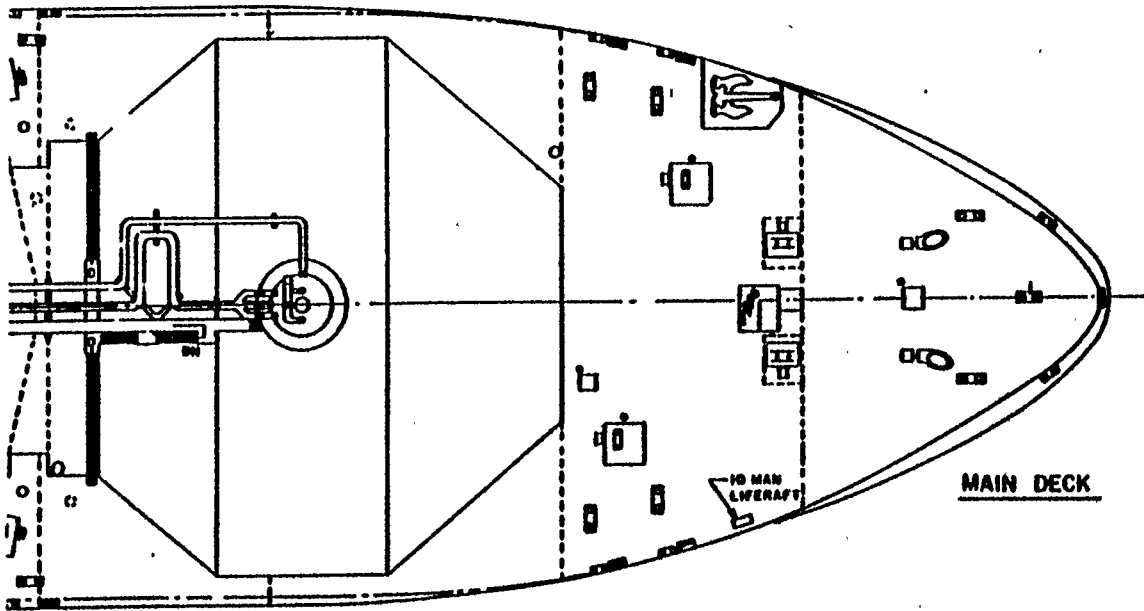
The National Shipbuilding Research Program has identified surface preparation and coating as both a labor intensive and costly construction area. Cost-saving equipment, techniques and technology are available. Increased productivity can be achieved through improved operational planning and greater understanding of efficient operating principles. Because these positive changes can be carried out by first-line supervisors and operators, the governing committee conceived the Paint and Surface Preparation Training Program.

The program was developed to improve the quality of coating work by enhancing the supervisor's ability to communicate systematically the fundamentals of marine coating technology to both entry level and experienced painters. Since training is an essential part of supervision, the program furnishes the supervisor with additional information he will need for the increasingly technical and specialized demands of shipyard coating work.

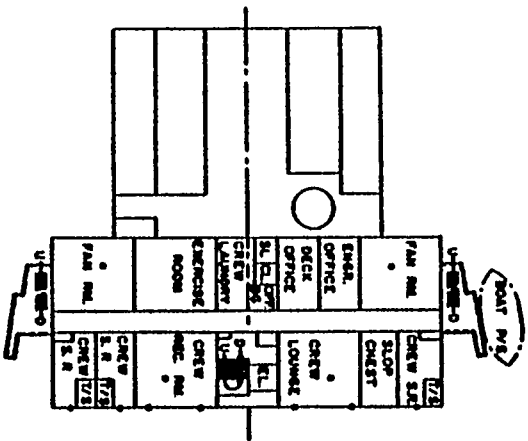
The program consists of two parts:

- a) Off-yard training seminars for the supervisor.
- b) Training material to be used by the supervisor with his crew.

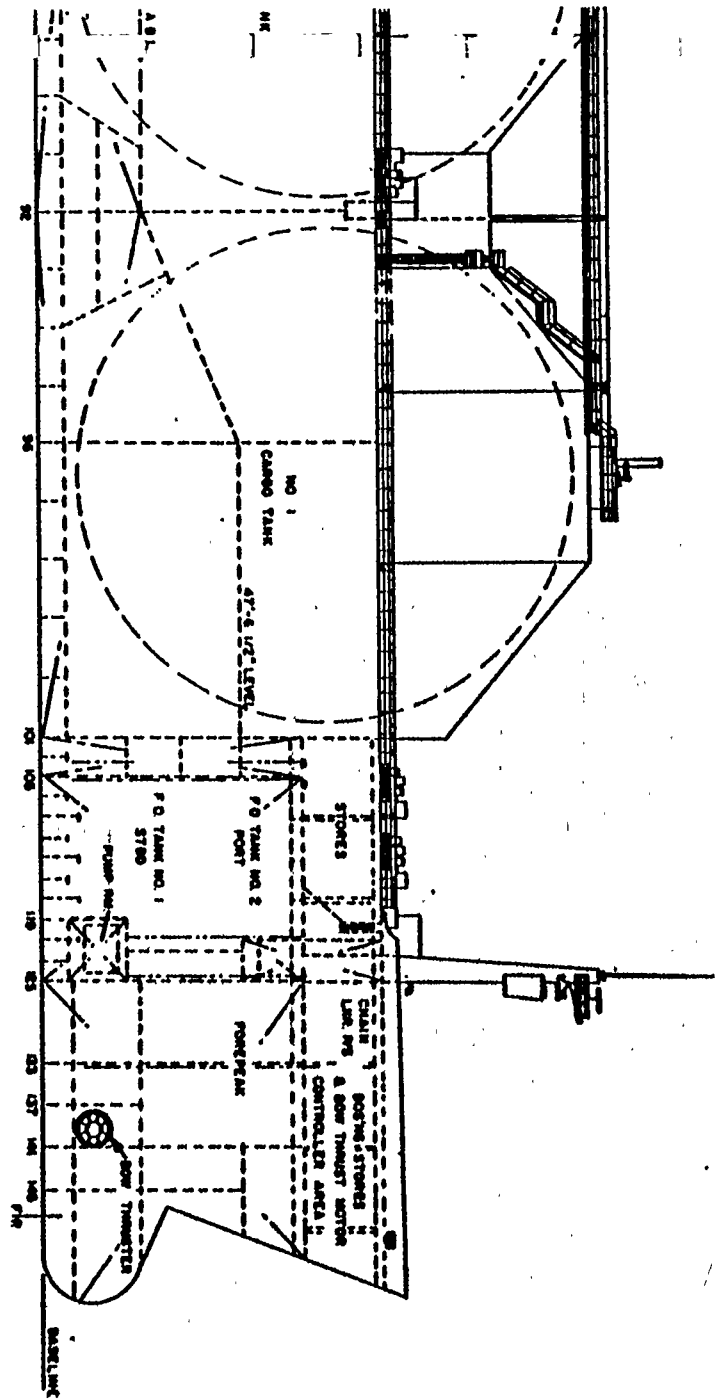
The Paint and Surface Preparation Training Program for Shipyard Personnel was carried out under the National Shipbuilding Research Program by Avondale Shipyards, Inc. and the Institute of Applied Technology, Washington, D.C. Guidance was provided by the Society of Naval Architects and Marine Engineers (SNAME) 023-1 Panel.



1ST LEVEL
DECK HEIGHT 15-10'
3 CREW S. R.



PROFILE



MARINE
COATING

PART A

PAIN'T AND SURFACE PREPARATION
TRAINING PROGRAM FOR SHIPYARD PERSONNEL

Part A: MARINE COATING TECHNOLOGY

Unit I: Controlling Corrosion

- TOPICS:**
- 1) Painting for Preservation
 - 2) Corrosion Costs Billions
 - 3) Corrosion is a Natural Cycle
 - 4) Aggressive Marine Environment Speeds Corrosion
 - 5) Design Affects Corrosion
 - 6) Controlling Corrosion by Painting

Unit II: Properties of Shipyard Paints

- TOPICS:**
- 1) Three Major Components Determine End Use Characteristics
 - 2) Common Marine Paints and Their Use

Unit III: Achieving the Maximum Paint Service Life

- TOPICS:**
- 1) Modern Paints Require Special Handling
 - 2) How to Read a Manufacturer's Data Sheet
 - 3) Curing Time is Critical for Adhesion
 - 4) Film Thickness is Related to Paint Performance
 - 5) Predicting the Dry Film Thickness During Paint Application
 - 6) Predicting Paint Coverage
 - 7) Special Techniques May be Needed for Intercoat Bonding

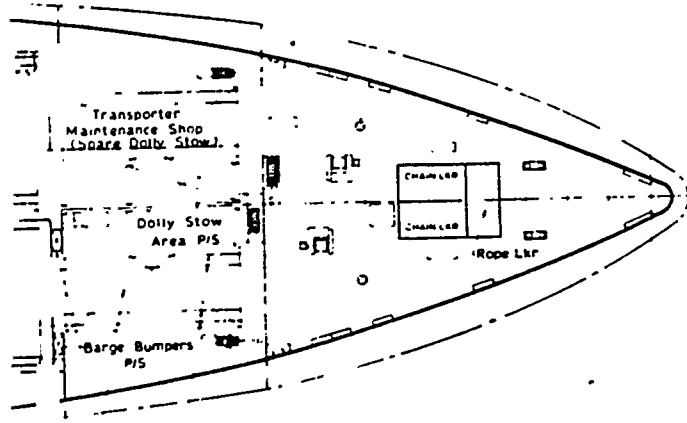
Unit IV: Failure Resulting from Paint Film Defects

- TOPICS:**
- 1) Why Defects Lead to Early Failure
 - 2) Identifying Film Defects and Their Remedies

PART A

PLANNING NOTES

UNIT I CONTROLLING CORROSION



Learning Objectives

After discussing this study unit, trainees should be able to:

1. Explain what corrosion is and why the marine environment accelerates corrosion.
2. Discuss the ways in which a ship's design can decrease the likelihood of corrosion.
3. Describe the two ways in which painting protects the surface and controls corrosion.
4. Identify 7 other reasons for painting a ship.
5. Explain the following key terms:
 - abrasion
 - adhesion
 - barrier protection
 - corrosion
 - fouling
 - sacrificial protection

Notes to the Instructor

1. CORROSION COSTS BILLIONS (p. A.3)

The economic effects of marine corrosion are staggering and the role that painting plays in extending the ship's service life should be emphasized to the painters. If all of the existing technologies were employed properly today, some \$10 billion could be saved. Paint, and the training to apply it properly, play a part in that savings. Painters should be aware of the significant role that they play in overall economics and specifically in shipyard economics.

Today paint department costs are the third largest item in new ship construction. Costs that can add up to 14-17% of total new construction costs. As an example, paint and solvent expenditures for a destroyer are estimated at \$9 million, with paint department labor at \$16 million. What are the comparable figures for the ships you are now working on?

2. CORROSION IS A NATURAL CYCLE (p. A.4)

The topic of corrosion is highly complex and goes beyond the scope of this book. (Further readings are recommended in the bibliography.) However, the basic principles must be known in order to understand how paint works to protect a ship's surface.

The most common form of corrosion that paint departments deal with is uniform corrosion. All steel is made of cells. Differences in the cells caused by the rolling process, stress, environmental conditions, porosity, minute deposits on surfaces, irregularities in the metal structure and other factors can result in an electrochemical reaction between them. In the presence of moisture, corrosion occurs between these different areas on the same piece of metal.

An excellent movie on this topic is available from International Nickel Company, called "Corrosion in Action." Write to INCo, One New York Plaza, New York, N.Y. 10004.

3. PHOTO OF STEEL PIPING THROUGH ALUMINUM (A.7)

This photo shows an advanced degree of corrosion on the aluminum deck and steel pipe. (The pipeline corrosion is more obvious in the slides.) Because of the electrochemical relationship of aluminum to steel, aluminum will corrode first. That is, it will corrode preferentially to steel.

4. BARRIER PROTECTION (A.9)

In explaining how paint protects by forming a barrier between the elements and the steel surface, it is commonly said that an effective coating film is impermeable to moisture. However, most organic paints used in shipyards are permeable to some degree. It is the reduction of permeability that is important in giving protection.

Equipment/Aids

Slide projector and screen

Optional: movie projector

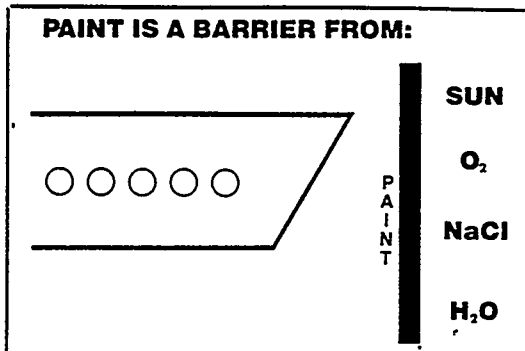
Unit Quiz

A 10-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz A-I:

- | | | |
|------|-------------|-------|
| 1. T | 7. T | 13. D |
| 2. T | 8. T | 14. D |
| 3. T | 9. B | 15. C |
| 4. T | 10. A, B, D | 16. B |
| 5. F | 11. B | 17. C |
| 6. T | 12. A, C | 18. A |

CONTROLLING CORROSION



The main reason for painting a ship is to form a barrier between the substrate (surface) and the elements that promote corrosion. In the marine environment, the sea water, salt, oxygen, and sun all contribute to the deterioration of the ship's surface.

Painting a ship serves three basic functions:

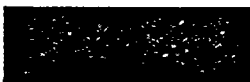
Preservation of the surface. "Save the surface and save all." Once the steel surface of a ship begins to rust, the entire structure is in danger of widespread corrosion. The purpose of the paint is to create a protective film which will protect against deterioration and corrosion.

SAFETY MARKINGS

Fire Protection Equipment



Caution/Physical Hazard



Safety Equipment



Functional. Paints are useful in ways other than corrosion control. Painting is important for:

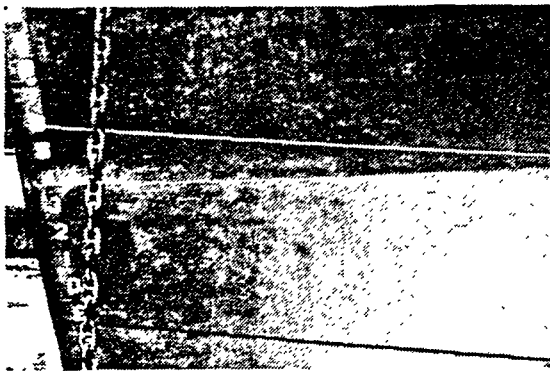
- Safety Markings. Certain colors are universal in the area of safety. For example:

red = fire protection equipment
 yellow = caution/ physical hazard
 green = safety equipment

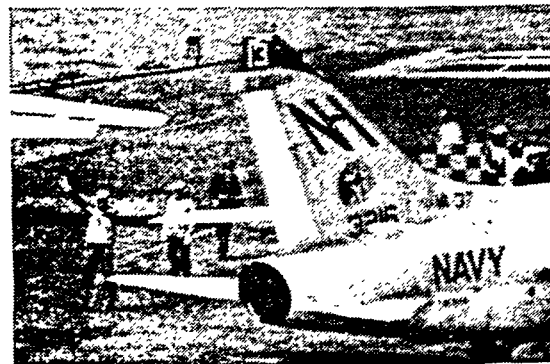
- Fire Retardation. Certain paints can delay the spread of fire and help to confine the flames to the original location. This is especially important in the ship's living quarters.



- Antifouling. Paints which are toxic to marine organisms control the growth of barnacles, grasses, and other marine life on the immersed surface. Marine fouling reduces the speed and maneuverability of a ship. Maintaining design speed on a ship with heavy fouling may require 10-20% more power. At today's fuel prices, this is an enormous cost factor.



- Identification Markings.



- Non-Skid Deck.

- Noise Control. Aids in the effectiveness of sonar equipment.

Decorative. Appealing to aesthetics is of secondary importance. However, the decorative purpose can also be functional. Providing comfortable living and working conditions and pleasant surroundings allows the ship's crew to work more efficiently and with less fatigue.

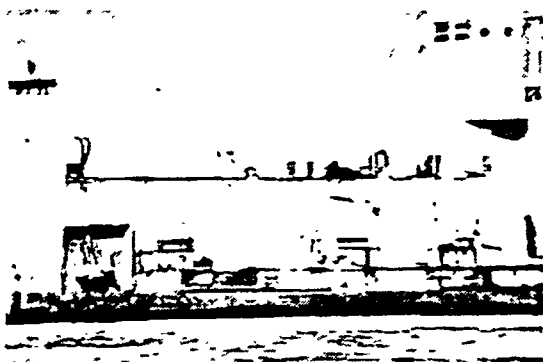
2. CORROSION COSTS BILLIONS

The purpose of controlling corrosion is to prolong the useful life, or service life, of a ship. Corrosion control is a very important factor in shipping economics and safety since corrosion involves the gradual destruction of a material. In the United States today, it is estimated that annual losses due to corrosion run as high as 80 billion dollars. In shipyards, this economic loss includes the costs of repair materials and yard labor as well as drydocking expenses which can range from \$10,000 to \$30,000 or more each day.



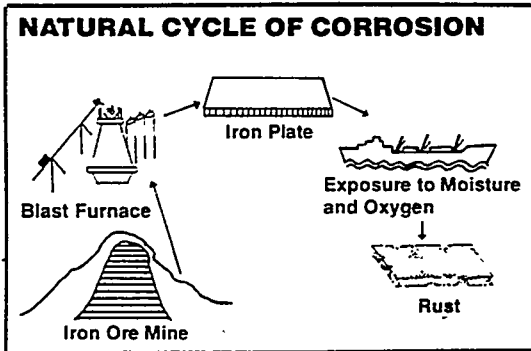
Corrosion is responsible for:

- interrupted service time and drydocking delays;
 - high maintenance costs;
 - costly repairs or replacement;
-
- cargo contamination;
 - safety problems when the metal deteriorates to the point that it can no longer support the stress it was designed to handle;
 - loss of important mechanical properties, such as the ability of the metal to conduct heat or electricity; and
 - unsatisfactory appearance: Who could take pride in such a rusty hull?



Since a ship is only serving its function when it is moving cargo, every day spent in a repair yard represents a financial loss. It is estimated that fifteen percent of the total costs of corrosion could be avoided if existing corrosion protection techniques were implemented properly.

3. CORROSION IS A NATURAL CYCLE



Corrosion is the process which causes steel to rust. Although corrosion is destructive to the steel, it is a natural process.

Iron and steel are not found naturally. They are manufactured products extracted from iron ore in a blast furnace process at very high temperatures. The iron ore, which does occur in nature, is a combination of the elements iron (Fe) and oxygen (O_2).

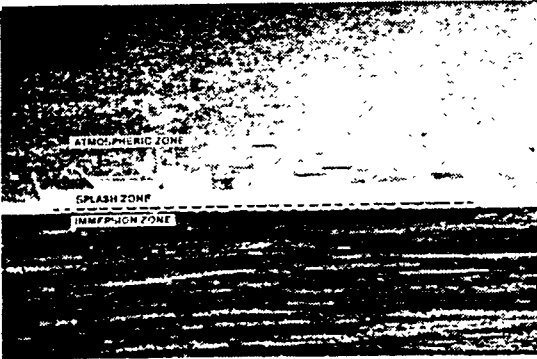
In the process of being converted into iron or steel, the ore acquires large amounts of energy. A metallurgist would say that it is made "unstable" in the process. Its natural tendency is to stabilize, to shed or release its acquired energy. During the release of this energy the iron or steel corrodes and rust is formed.

Chemically, rust is the same as iron ore. Both are made of iron and oxygen; both are iron oxide. The process of corrosion is a cycle of nature.

All metals will corrode over time. Some metals, including bronze and stainless steel, corrode more slowly than iron. These more "noble" metals are also more costly and they are used only for special purposes in ship construction.

4. AGGRESSIVE MARINE ENVIRONMENT SPEEDS CORROSION

Two elements are essential for bare metal to corrode: moisture and oxygen. Other elements such as warm air, gases, acids, salt, and dirt will accelerate rusting. All of these are present in the marine environment.



There are three distinct corrosion zones on a ship:

Immersion zone. The ship's underwater hull is constantly immersed in sea (salt) water. Artificial pollutants, including oil and chemical spills attack steel. Biological fouling deteriorates the protective paint and exposes the metal to rusting.

Splash zone. The zone above the water line that is exposed to salt spray, humidity, foul weather, and the sun's rays which break down the paint film.

Atmospheric zone. The superstructure, such as stacks, masts, spars, radar and sonar devices are also exposed to the weather, salt spray, the sun's ultra violet rays, and to fumes and gas which condense on their surfaces.

Ships are also in danger of abrasion damage caused by bumping against piers, tugs, and barges, or from operating in shallow water. As the layers of paint are rubbed away, the exposed metal is subject to corrosion attack.

Corrosion can occur everywhere on a ship. In interior spaces corrosion can cause extensive damage to tanks, voids, piping, and decks.

5. DESIGN AFFECTS CORROSION

Poor construction techniques, choice of materials, and design of a ship can increase the likelihood of corrosion.

The rate of rusting of metals is increased in areas where two different metals are joined. This type of corrosion, called galvanic corrosion, is a major cause of deterioration of underwater steel where the propeller and weld metal are dissimilar to the plating. Common examples of the joining of two dissimilar metals on a ship are:



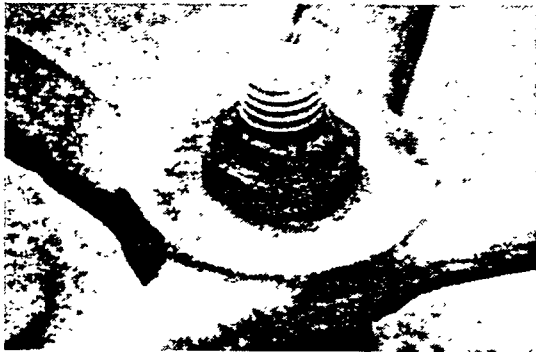
- Steel hull and bronze propeller.



- Aluminum house and steel deck.



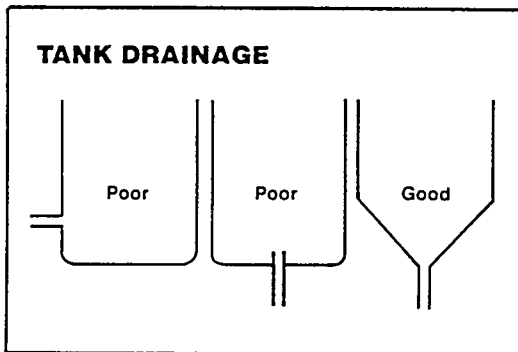
- Aluminum stanchion and bronze lifeline.



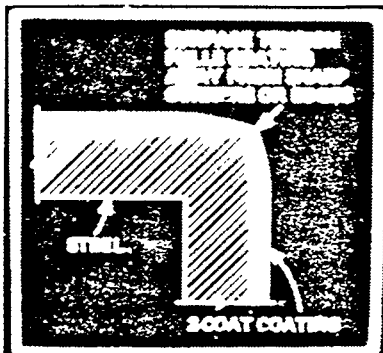
- Steel nut on copper alloy valve control.



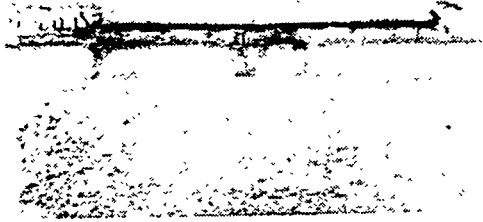
- Steel piping through aluminum.



Good drainage is essential in tanks and pipes. They should be designed to empty easily, avoiding pockets of still trapped water and corrosive solutions.

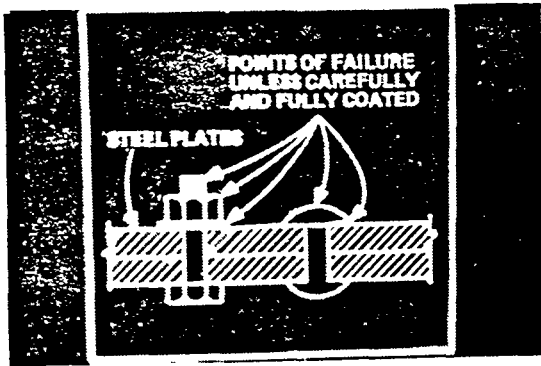


Sharp edges on a structural steel member promote corrosion. The paint draws thin at the edge, permitting moisture penetration or rapid wear and the exposure of bare steel. Good practice requires the rounding of edges before painting. (If this is impossible, edges may be striped with an extra coat of paint.)



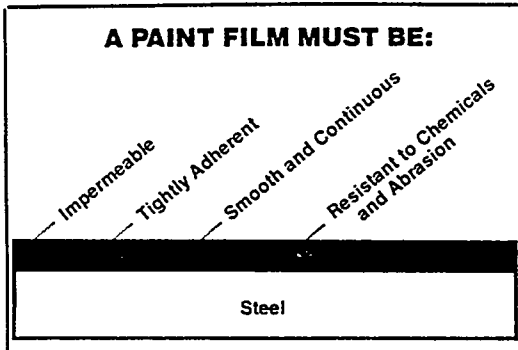
Skip or spot welding (intermittent welding) and lap welding increase the possibility of corrosion problems by creating crevices which trap moisture and pollutants. A smooth continuous weld seam and butt welding are preferred to assure proper paint coverage. Naturally, economics play a big part in design. If lap welding must be used, the laps should be filled with fillet welding or suitable caulking compound.

While butt welding is preferred to lap welding and countersunk rivets are preferred to other types for corrosion reduction, this is not always possible.



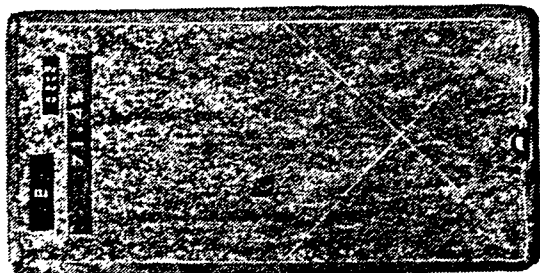
Riveted joints should be free of gaps. Use insulation material or caulking to fill in pockets which cannot be reached with coatings. Additional brush coats of the coating on rivet edges will also help.

There are two ways in which painting protects the surface. A coat of paint controls corrosion either by acting as a barrier and preventing contact between the metal and the corrosive elements, or through the action of protective pigments.



Barrier protection. To act as an effective barrier, the paint film must demonstrate the following characteristics.

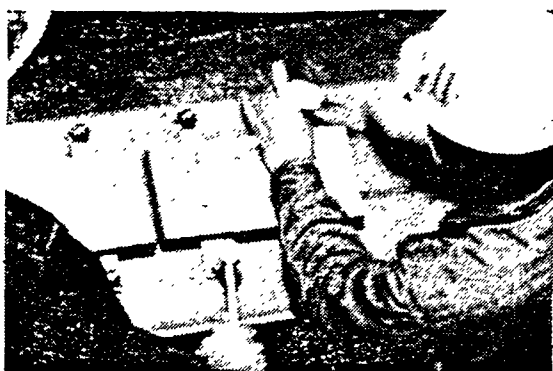
- Reduced impermeability to moisture and oxygen. If moisture and oxygen readily pass through the paint film, corrosion may take place even though the coating is undamaged and appears to be intact. Large masses of rust could form under the coating, which would eventually lift the coating off the surface.
- Tight adherence to the surface. A coating must be highly adherent, or form a tight membrane over the surface. Even if a coating allows some moisture to penetrate, it can still provide good protection if there is no area underneath the film in which the moisture can collect.
- Smooth and continuous film. The paint film must be applied evenly and must be free of small skips, voids, or pinholes. These tiny imperfections in the paint surface will allow water and oxygen to enter. A tiny spot of corrosion may quickly spread under the paint, stretching, cracking, and lifting the film as it progresses.
- Resistance to chemicals and abrasion. To successfully provide barrier protection, the paint material must be able to resist harsh chemicals found in the air and seawater, or carried in the ship's tanks. It must also resist scratching from dropped tools, movement of workers and equipment, and scraping against piers or a dry-dock.



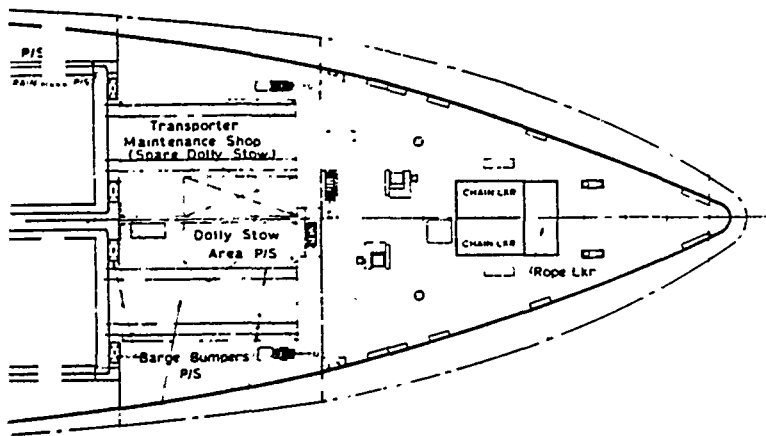
Protective pigments. The pigments in a paint can be either reactive or sacrificial to control corrosion.

- Sacrificial pigments react with corrosive elements in the environment. These metallic pigments corrode before the steel can be attacked. For example, when a scratch or a break occurs in a zinc-rich paint film, water and oxygen combine with the metallic zinc dust to form zinc oxide or "white rust." Over time, the zinc particles will corrode away and the paint's protective ability will be lost.

It is especially important to mix zinc-rich paints thoroughly so that all of the metallic dust particles which give this sacrificial protection are incorporated in the paint film. Constant agitation of the paint pot is usually recommended.



Painting is not the only method of controlling corrosion but it is the most commonly used and most cost effective method for most ship surfaces. Underwater hulls are sometimes protected by "waster pieces" (sacrificial anodes) or by sophisticated systems which monitor electric current flow. These systems are used together with a high performance paint system to protect the steel, increase drydocking intervals, and reduce the enormous costs of ship corrosion.



PART A

QUIZ

UNIT I CONTROLLING CORROSION

NAME:

DATE:

INSTRUCTOR:

GRADE:

Check the correct answer.

- | | <u>TRUE</u> | <u>FALSE</u> |
|--|-------------|--------------|
| 1. Painting slows down corrosion but cannot prevent it. | [] | [] |
| 2. Because all organic coatings can be penetrated by moisture to some degree, they must be tightly adherent in order to give barrier protection. | [] | [] |
| 3. The rate of corrosion is increased when steel rivets are used on an aluminum deck. | [] | [] |
| 4. The use of antifouling paints can aid in maintaining the speed, maneuverability, and fuel consumption of a ship. | [] | [] |
| 5. Decorative painting of a ship's interior spaces does not serve any function and should not be taken into consideration. | [] | [] |
| 6. Rusting can only occur if moisture and oxygen are present on the steel surface. | [] | [] |
| 7. The superstructure of a ship, such as stacks, masts, and radar devices, are exposed to corrosive elements, even though they are not immersed in salt water. | [] | [] |
| 8. Good welding practices, such as continuous fillet welding, can decrease the possibility of corrosion attack from moisture and pollution. | [] | [] |

Circle the most correct answer.

9. Corrosion of a ship is NOT responsible for:
- A. drydocking delays
 - B. growth of marine organisms
 - C. high maintenance costs
 - D. safety problems

10. The three distinct corrosion zones of a ship are:

- A. immersion zone
- B. atmospheric zone
- C. weather deck zone
- D. splash zone

11. To act as an effective barrier against corrosion, a paint film must be:

- A. high gloss
- B. resistant to moisture and oxygen
- C. zinc-rich
- D. fire retardant

12. Which of the following design factors can promote corrosion on a ship?

- A. sharp edges
- B. fillet welding
- C. trapped water in pipes
- D. butt welding

13. The protective pigments in a coating: (Which is false.)

- A. can form a tougher coating by reacting with other paint elements.
- B. reduce contact between the metal and corrosive elements.
- C. can react with other corrosive elements and corrode in preference to steel.
- D. must be resistant to chemicals.

14. Which statement about skip welding is false?

- A. Skip welding is less expensive than continuous welding.
- B. A smooth continuous weld seam is a preferred surface for applying paint.
- C. Crevices created by skip welding may contribute to corrosion problems.
- D. Caulking skip weld seams prior to painting is not cost efficient.

15. Sharp edges on a steel member should be rounded before painting:

- A. for safety reasons.
- B. only in potable water tanks and crew's quarters.
- C. to prevent the paint from drawing thin and quickly exposing the steel.
- D. to prevent the paint from edge cracking.

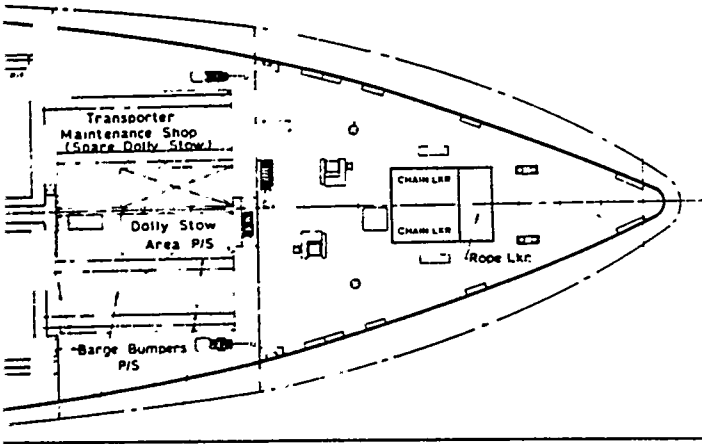
Match the following safety markings with their appropriate colors:

- | | |
|-------------------------------------|-----------|
| 16. Fire protection equipment _____ | A. Yellow |
| 17. Safety equipment _____ | B. Red |
| 18. Caution/physical hazard _____ | C. Green |

PART A

PLANNING NOTES

UNIT II PROPERTIES OF SHIPYARD PAINTS



Learning Objectives

After discussing this study unit, trainees should be able to:

1. Identify the three major components of paint and describe the function of each.
2. List nine commonly used generic coatings and discuss their recommended use in the marine environment.
3. Explain the purpose of antifouling paints.
4. Explain the following key terms:
 - antifouling
 - binder
 - pigment
 - resin
 - solvent

Notes to the Instructor

It is not possible to talk about generic types of paints with complete accuracy. The information given here is general. Specific products produced by different manufacturers, although belonging to the same generic group, may have very different performance characteristics. This is true because of the numerous additives which may be used to alter the basic characteristics of the paint. Different proportions of ingredients may be used or the quality of the grind may vary.

The material presented here will provide a basic understanding of why certain types of paints are chosen for different areas of the ship. In teaching this material to your supervisors, you will probably want to discuss the various types of paint in sequence. A blueprint of the ship would be useful in identifying various shipboard spaces and the type of paint recommended for use.

For training operators, consider these points:

- a. Select the coating types in use on a current job.
- b. Emphasize the properties of the paint which make it the right choice for that job.
- c. Diagrams, schematics, or blueprints of the ship should be available to identify the area to receive each type of coating.
- d. Introduce Topic 2, Unit III, "How to Read a Manufacturer's Data Sheet," at this point. Discuss the properties of the specific paint you are using.

Equipment/Aids

Slide projector and screen

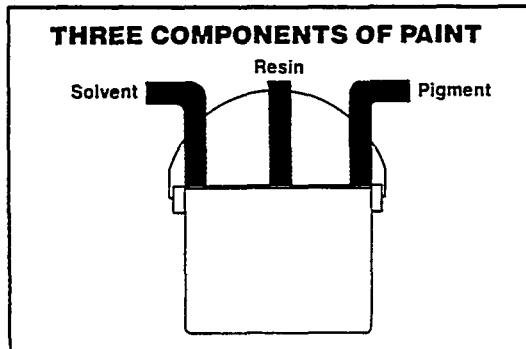
Optional: Manufacturer's data sheet
Ship blueprints

Unit Quiz

A 15-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz A-II:

- | | | | |
|---------|-------|----------|-------|
| 1. C | 6. D | 11. A, D | 16. T |
| 2. B | 7. B | 12. D | 17. F |
| 3. A, C | 8. A | 13. A, B | 18. T |
| 4. B | 9. D | 14. T | 19. T |
| 5. A | 10. C | 15. F | 20. F |



Of the several hundred chemicals which are blended into a can of paint, three major components of the paint determine the end-use characteristics. These three components are

- the resin (binder),
- the solvent, and
- the pigment.

The resin, also called the binder, is the film forming portion of paint. It is responsible for the adhesive and protective qualities and the durability of the paint. Generic paint types take their name from the resin used in their formulation. Examples are alkyds, vinyls, epoxies, chlorinated rubber and urethanes. The resin is "non-volatile"; it remains on the surface once the paint has dried.

The solvent is the "volatile" portion of the paint; it evaporates from the surface during application and drying. The function of the solvent is to dissolve the resin so that it may be applied easily. Solvents will affect the paint's consistency, leveling, drying, durability and adhesion. They must be carefully selected and mixed as required for use with different resins.

The pigment portion is the solid portion of paint. Pigments can serve many functions, such as

- providing color and hiding power;
- resisting weather;
- protecting from the effects of sunlight;
- increasing the paint's adhesion; and
- decreasing the degree of moisture penetration (permeability).

The use of additives or extenders can aid in controlling gloss, adjusting consistency and durability, and reducing pigment settling in the paint.

A. Alkyd. Alkyds have been called the "workhorse of the coatings industry." The Navy and other government services are the largest users of silicone alkyds. Their usage on commercial ships has decreased considerably and has been replaced by other generic types, particularly epoxies and chlorinated rubbers. Alkyd is a synthetic resin which is modified with oils. Because of the oil, alkyds penetrate steel surface irregularities and pits and they adhere well. In marine applications, alkyds are used above the water line as they are unsuitable for use underwater. Alkyds are commonly used as both primers and topcoats on ship interiors, engine rooms, holds, tank hatches, pipes, floor plates, store and pump rooms.

When heat resistance is required on pipes, stacks, and valves, alkyds are modified with silicone. Silicone alkyds have good heat resistance, very good moisture resistance, and good chemical resistance. Silicone alkyds are used basically because of their superior gloss and color retention when compared with standard alkyd materials.

Minimum surface preparation: limited. Alkyds are tolerant of hand and power tool cleaning. In maintenance and repair (M & R) work, this is acceptable. However, new construction weather deck application of alkyds calls for a minimum of commercial blast.

SLIDE OF CHART

Advantages

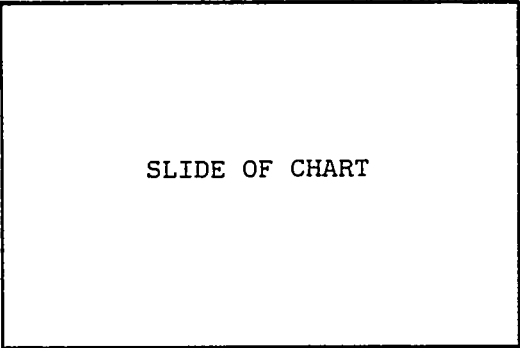
- One-package coating
- Fair exterior durability
- Moderate cost
- Excellent flexibility
- Good adhesion to most surfaces, including poorly prepared surfaces
- Easy to apply
- Good gloss retention

Disadvantages

- Poor chemical and solvent resistance
- Fair weather resistance
- Poor heat resistance
- Poor immersion resistance

B. Bituminous. Bituminous coatings - asphaltic and coal tar pitch materials - are used in exposures where water impermeability is important and their black color is not objectionable. They are durable, bond well to steel, and can be applied in thick films at a relatively low cost. Coal tar pitch is superior to asphalt as a water barrier but becomes brittle when exposed to air, heat, and sunlight. Therefore, pitch is the preferred bituminous coating for shipbottoms. Reinforcing metallic pigments are often added.

Minimum surface preparation. for immersion service, a commercial blast is generally recommended. Fresh water wash, scraping, and power tool cleaning of bad areas is acceptable for recoating.



SLIDE OF CHART

Advantages

Low cost
Good moisture barrier
Good corrosion protection
Good thick film build

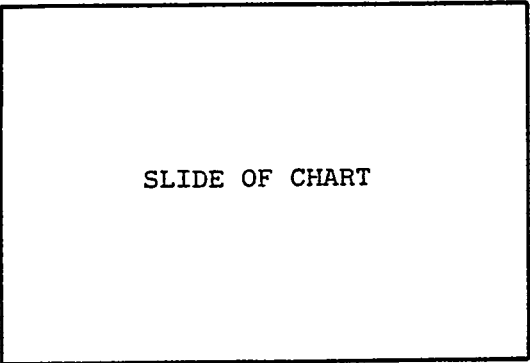
Disadvantages

Poor weathering properties
Black color only
Sensitive to cathodic protection currents
Sensitive to temperature change

C. Chlorinated rubber. Chlorinated rubber is formed by exposing natural rubber to chlorine gas. The resin which results is outstanding in its resistance to water and common corrosive chemicals. It is a good water vapor barrier and resists strong acids, alkalis, mineral oils, mold, and mildew. In addition, it is odorless, tasteless, non-toxic and fire retardant.

Chlorinated rubber may be recommended for all exterior ship areas: bottom, boottop, weather deck and superstructure. It is very quick drying compared to other paints and may be dry to touch in 30 minutes. Recoat or full cure time is usually 4 to 8 hours.

Minimum surface preparation: tolerant of power tool cleaning or spot blasting for recoating; a near-white blast is recommended in new work, especially for immersion service.



SLIDE OF CHART

Advantages

Rapid drying and recoating
Excellent chemical resistance
Excellent water resistance
Good water resistance
Good durability
Applicable at low temperatures

Disadvantages

Poor solvent resistance
Poor heat resistance
Blasted surface desirable
Low film build per coat

D. Epoxy. The epoxy resin is used in a large group of epoxy coatings which have found more and more uses in shipyards because of their excellent combination of properties: adhesion, toughness and chemical resistance. Amine cured, polyamide cured, and coal tar epoxies are used as shipbottom coating systems.

Epoxy polyamides are two-package paints which have a longer pot life than other epoxies and have very good resistance to continuous immersion. They are used as a prime coat in living spaces and as a topcoat over inorganic zinc coated steel on the splash zone hull, and topside. Epoxy polyamide may be specified for boottop, weather deck, and superstructure areas. They are also used on the interior of oil, chemical, and water tanks. Effective corrosion inhibiting primers using zinc chromate pigment can be made with epoxy polyamide vehicles. This coating is very sensitive to temperature: the ambient temperature for application, pot life, curing time must be above 50 degrees F. Below this temperature most polyamide epoxies will not cure.

Minimum surface preparation: a near-white blast is specified for good adhesion in new construction work. In maintenance and repair, spot blasting and power tool cleaning is acceptable.

SLIDE OF CHART

Advantages

Excellent chemical and solvent resistance
Excellent water resistance
Very good exterior durability
Hard, slick film
Excellent adhesion
Excellent abrasion resistance
Good caustic resistance

Disadvantages

Two-package coating — limited pot life
Curing temperature must be above 50 degrees F
Poor gloss retention
Film chalks on aging
Blasted surface desirable
Topcoating may require blasting depending on surface and cure time

Coal tar epoxy is a blend of coal tar pitch and epoxy resin. There are many different formulations which balance chemical resistance, physical resistance, adhesion and flexibility. All formulations continue to cure with time. As they continue to harden they lose flexibility. Humidity and temperature affect the rate of cure. Newly painted coal tar epoxy surfaces must be protected from contact with water for 24 hours; service cure is a minimum of five days.

Resistance to abrasion, impact, water and penetration by marine organisms is very good. Coal tar epoxy is therefore used on ship-bottoms, and ballast tanks.

Minimum surface preparation: near-white blast for new work; fresh water wash, spot blast of bad areas, and brush blast of areas where existing coal tar epoxy coats are exposed in rework.

SLIDE OF CHART

Advantages

Good resistance to fresh and salt water
Good abrasion resistance
Good film build
Excellent resistance to petroleum products

Disadvantages

Personal protection needed
Heavy chalking
Poor resistance to low concentrations of alkalis, alcohols
Slow curing
Contains suspected carcinogens

Hydrocarbon-epoxies: Hydrocarbon modified epoxy coatings have many of the desirable properties of the coal tar epoxies without many of the weaknesses. These coatings have excellent water resistance and can be designed to have very low temperature curing characteristics. These materials can be used as undercoats for the underwater, boottop, topside areas. They have good recoatability and can be overcoated with a number of different types of topcoats.

Advantages

Excellent water resistance
Good abrasion resistance
Good film bond
Non-toxic
Excellent adhesion
Excellent exterior durability
Low temperature cure

Disadvantages

Two package coating - potlife
Poor gloss and color retention
Poor resistance to some solvents and petroleum products

Epoxy-acrylic: Epoxy resin coatings can be modified with resins such as acrylics to provide other characteristics such as improved cosmetic properties. This makes them much more desirable as a topcoat for hull and topside coatings.

Advantages

Improved cosmetic properties
Improved aged recoatability properties
Improvement in resistance to certain chemicals

Disadvantages

Solvent abrasion resistance
not as good as pure epoxy

E. Inorganic zinc. Inorganic zinc-rich coatings consist of at least 80% zinc dust. The zinc dust is dispersed in the vehicle. Zinc dust has very high hiding power and is used chiefly in paints which inhibit corrosion. It serves as the sacrificial material; whereby the steel, such as a ship's hull, is protected at the expense of the zinc. Inorganic zinc is also used as corrosion protection on weather decks, superstructure, and metal surfaces on off-shore structures.

Minimum surface preparation: spot blasting required for recoating; new construction requires near-white blast. A minimum of $1\frac{1}{2}$ mil anchor pattern is required for good adhesion.

SLIDE OF CHART

Advantages

Offers one-coat protection under many service conditions
Excellent exterior durability
Excellent heat resistance
Excellent abrasion resistance
Provides "galvanic" protection properties
Provides "permanent" primer capability when used in conjunction with proper topcoats and/or maintenance practices
Good resistance to immersion in oils and organic solvents
Self-curing

Disadvantages

High cost
Spray application only — skilled applicators required for successful job
Not suitable for acidic or caustic service unless properly topcoated
Requires careful selection of tie-coats and topcoats for service involved
Selected temperature and humidity effects — depending on type used
Constant stirring necessary
Long cure time — avoid moisture during initial cure time (one hour)

F. Polyurethane. This resin is among the newest of the synthetic resins used for coatings. It is used in a variety of formulations from hard glossy enamels through soft flexible coatings, to insulating foams. In general, the hard films have excellent solvent resistance and good acid and alkali resistance, but do not weather well. The flexible coatings have excellent physical properties including good resistance to salts. They are suitable for use on boottop, topside, weather deck, and superstructure areas. Urethanes are somewhat difficult to apply and maintain and may produce strong toxic effects in some operators.

Minimum surface preparation: tolerant of power tool cleaning for recoating; a near-white blast is recommended for new construction.

SLIDE OF CHART

Advantages

Excellent gloss retention
Can be applied at low temperatures
Excellent chemical and solvent resistance
High hardness
Excellent durability
Excellent flexibility in exterior exposure
Regular to high film build
Recoatable
Very good resistance to abrasion
Very good resistance to fresh and salt water

Disadvantages

Gloss drop with high humidity
Limited pot life
High cost
Good clean, dry surface required
Two-component
Sensitive to moisture — containers must be tightly sealed
Highly toxic
Difficult to apply
Difficult to overcoat

G. Vinyl. Vinyls make up a large group of coatings, which first achieved commercial importance in the early 1930's. Their use has grown steadily so that they have become one of the most versatile and widely used types of coatings in other industries outside of marine. Vinyl coatings have excellent durability and resistance to acids, alkalis, chemicals and seawater and they will not support combustion.

Vinyls are used for coating marine equipment. Coal tar pitch may be added to form vinyl pitch (vinyl coal tar) to provide additional underwater protection for a shipbottom.

Minimum surface preparation: brush blasting of bad areas, hydroblasting, power tool cleaning, scraping or fresh water washing recommended for recoating; new work requires a near-white blast.

Acrylic resins added to vinyls improve brushing and gloss and color retention. These vinyl acrylics are excellent for use as an exterior coating in humid atmospheres, such as the boottop, weather deck, and superstructure areas of a ship.

SLIDE OF CHART

Advantages

Rapid drying and recoating
Excellent chemical resistance
Excellent fresh and salt water resistance
Excellent durability
Very good gloss retention
Applicable at low temperatures
Excellent acid and alkali resistance

Disadvantages

Poor solvent resistance
Poor heat resistance
Low film build per coat
Poor adhesion
Poor tolerance of moisture during application

H. Anti-fouling. Anti-fouling paints are used on shipbottoms to inhibit the attachment of barnacles, grass, algae, and other marine growths. Cuprous oxide, a copper toxic, is the major anti-fouling ingredient in the various coatings which are used on shipbottoms -- bituminous, vinyl, and chlorinated rubber. Organotin compounds are also used as toxic substances. Cuprous oxide provides good resistance to shell fouling. Resistance to the growth of weeds and grasses is boosted when organotins are also added.

The choice of which anti-fouling paint to use and the number of coats is governed more by the amount of time a ship spends docked at piers than by time at sea. For example, an active tanker rarely becomes fouled because it has a relatively short turn around time. However, ships that spend a lot of time in ports, which are heavy fouling areas, require a high grade anti-fouling paint.

The use of ablative anti-fouling paints has increased with the extended drydock cycles (greater than three years) and the increased cost of fuel. The number of coats of an ablative anti-fouling coating can be tailored to the service and drydock cycle of a ship.

Standard anti-fouling paints have a decreasing curve of toxic activity and, therefore, will not normally provide continued anti-fouling capability for over two years without cleaning.

Minimum surface preparation: tolerant of power tool cleaning for recoating; for new work, a near-white blast is recommended.

I. Water Based. The term "water based" really means that the paint is water soluble, i.e., it can be thinned with water, and the painting tools cleaned up with water. There are two general types of water borne or water thinnable paints. The most widely used is the common retail variety latex or vinyl latex formulation. It is an emulsion paint which is applied by brush or roller and dries very quickly to a flat or low sheen semigloss finish. The varieties of water borne coatings available to the marine market today include acrylics, epoxies and cementitious coatings. The acrylics are normally used as finishes where cosmetics is important.

The advances in epoxy water borne coatings have been quite rapid. Coating systems for water tanks, cargo tanks and exterior areas are available.

The cementitious coatings, some modified with resins such as epoxies, are available and finding a place in the market. Reduced surface preparation requirements is one of the reasons these coatings are being considered.

Although water based paints have so far been limited to the interiors of the ship - crew quarter, work spaces and the like - it is expected that eventually they will be used on all areas of the ship.

Water based paints have some real advantages. They can be applied without interfering with other trades, and are not a fire hazard since flammable solvents are not needed for thinning or clean-up. Also, they are not a health hazard because they do not exude toxic vapors. However, good ventilation is necessary, especially in confined areas during application and curing, to get rid of water vapors which can resolute the coating and prevent proper curing. These paints can be made in fire retardant formulas and are ideal for maintenance use.

Minimum Surface Preparation: brush blasting of bad areas, hydroblasting, power tool cleaning, to remove rust corrosion before spot priming with primer recommended by the coating manufacturer; new work requires near-white blast, followed by the recommended primer.

Advantages

Rapid drying and recoating
Excellent durability
Excellent adhesion
Good gloss retention
Ease of application
No odor
No flammable solvents needed for thinning
Fire safe

Disadvantages

Cannot be applied at temperatures below 40 degrees F
Low film build
Requires solvent type synthetic resin primer
Presently limited to interior spaces
Must be stored at controlled temperatures to avoid deterioration from freezing or extreme heat

12. Which statement concerning inorganic zinc is false?

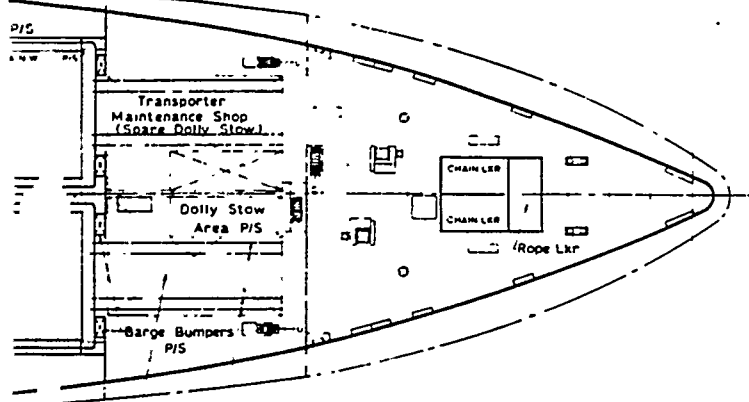
- A. Inorganic zinc resists heat, abrasion, and immersion in oils and organic solvents.
- B. Inorganic zinc requires skilled applicators and has a high initial cost.
- C. Inorganic zinc requires constant agitation to keep the metallic dust dispersed during application.
- D. Inorganic zinc has a short cure time; usually it may be topcoated within 3 hours.

13. Two paints which are moisture sensitive while curing and must be protected from contact with water for 24 hours are

- A. coal-tar epoxy
- B. inorganic zinc
- C. chlorinated rubber
- D. vinyl acrylic

Check the correct answer.

	TRUE	FALSE
14. Anti-fouling paints contain poisonous ingredients to keep marine organisms from growing on the ship's hull.	[]	[]
15. The two-package epoxy polyamides have a shorter pot-life than other epoxies and cannot be used for immersion service.	[]	[]
16. Resistance to abrasion, impact, and fouling are important characteristics for shipbottom coatings.	[]	[]
17. The disadvantages of using inorganic zinc -- long cure time, constant stirring, spray application only -- make it unsuitable for coating most areas of a ship.	[]	[]
18. Chlorinated rubber has a rapid drying time, strong resistance to chemicals and water and is recommended for exterior ship areas.	[]	[]
19. Epoxy polyamides are temperature sensitive; minimum application temperature is 50°F.	[]	[]
20. A good commercial blast is acceptable for most paints being applied in new construction work today.	[]	[]



PART A

QUIZ

UNIT II PROPERTIES OF SHIPYARD PAINTS

NAME: _____ DATE: _____ INSTRUCTOR: _____ GRADE: _____

Circle the most correct answer.

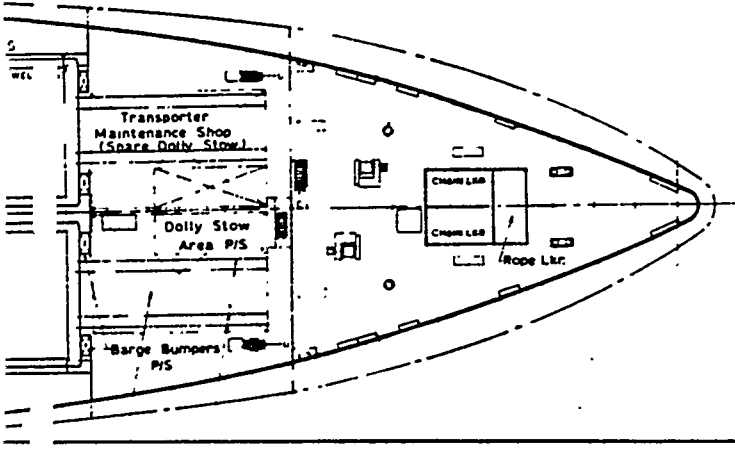
1. The generic name of a paint comes from the _____ used in its formulation.
 - A. vehicle
 - B. pigment
 - C. resin
 - D. solvent
2. The pigment portion of a paint can serve many functions. Which is NOT a function of pigments?
 - A. Pigments resist weathering.
 - B. Pigments dissolve the resin making the paint flowable.
 - C. Pigments provide color and hiding power.
 - D. Pigments decrease the degree of permeability.
3. Two kinds of resin are
 - A. alkyd
 - B. generic
 - C. epoxy
 - D. volatile
4. The most widely used oil-modified resin which is unsuitable for below the waterline of a ship is
 - A. bituminous
 - B. alkyd
 - C. chlorinated rubber
 - D. epoxy
5. Coatings used for shipbottoms which contain coal-tar pitch are
 - A. bituminous
 - B. alkyd
 - C. chlorinated rubber
 - D. vinyl

6. Which resin is used for coating several areas of a ship and is amine or polyamide cured?
- A. vinyl
 - B. bituminous
 - C. alkyd
 - D. epoxy
7. The paint that contains a high percentage of a metallic dust which serves as a sacrificial material is
- A. red lead alkyd
 - B. inorganic zinc
 - C. epoxy polyamide
 - D. coal-tar epoxy
8. The volatile, or evaporating, portion of a paint is the
- A. solvent
 - B. binder
 - C. pigment
 - D. vehicle
9. Alkyds, modified with _____, have high heat resistance, as required for coating pipes, stacks, and valves.
- A. enamel
 - B. coal tar
 - C. pigment
 - D. silicone
10. When this substance is added to vinyl, gloss retention and brushing are improved.
- A. coal tar
 - B. silicone
 - C. acrylic
 - D. binder
11. Painters should pay special attention to the use of protective clothing, creams, and respirators when spraying (Choose 2)
- A. two-package epoxy
 - B. chlorinated rubber
 - C. vinyl acrylic
 - D. polyurethane

PART A

PLANNING NOTES

UNIT III ACHIEVING THE MAXIMUM PAINT SERVICE LIFE



Learning Objectives

After discussing this study unit, trainees should be able to:

1. Explain the importance of the information provided in the manufacturer's data sheet:
 - catalyst
 - DFT
 - dry to handle
 - dry to recoat
 - flash point
 - gloss
 - induction time
 - mil
 - mistcoat
 - pot life
 - profile
 - shelf life
 - tiecoat
 - viscosity
 - volume solids
 - WFT
2. Discuss the relationship of film thickness to paint performance.
3. Describe how proper curing affects the service life of a paint.
4. Measure WFT.
5. Predict the dry film thickness from wet film thickness measurements.

Notes to the Instructor

1. THE WET FILM THICKNESS GAGE (p. A.29)

This gage is a very important tool for the painter. It will help him to adjust his gun and set his speed for that job.

Emphasis should be placed on:

- the need to measure WFT immediately, before the solvent has time to flash off; and
- the difficulties of using this gage when applying inorganic zinc and other heavily pigmented paints.

Equipment/Aids

Slide projector and screen
WFT gage

Standard Data Sheet (Shipbuilders & Marine)
Manufacturer's data sheets in current use

Discussions/Group Work

Topic 2. Standard paint data sheet. Compare the proposed standard paint data sheet to those provided by manufacturers of paints currently used in your yard. Review items that are critical for application of the products on your current job.

Topic 5. Determining DFT from WFT. After reviewing the example given in the text, ask the trainees to individually calculate the DFT based on 4 mils WFT and a paint with 60% volume solids.

Unit Quiz

An 18-question quiz is provided with this unit. Duplicate copies for each participant. Allow 10 minutes to complete the quiz. Discuss each question and answer thoroughly.

Answers to Unit Quiz A-III:

- | | | |
|------|---------|-------|
| 1. D | 7. B | 13. T |
| 2. E | 8. B, D | 14. F |
| 3. C | 9. D | 15. F |
| 4. A | 10. B | 16. T |

ACHIEVING THE MAXIMUM
PAINT SERVICE LIFE

The high performance paints that are formulated and used today require special handling and application to achieve the extended performance life which the paint manufacturers promise.

The range of raw materials which go into these paints is staggering. A manufacturer may have to stock 500-600 different chemicals in order to produce a full paint line. Because of the many chemicals used to achieve the desired protective properties, these new paints are "touchy." They demand careful mixing and a well prepared surface. Primers may demand pre-treatment.

Years ago paints were simple blends of natural oil and pigment. They were all similar and were easily thinned with solvents such as mineral spirits or turpentine. The oils had some ability to penetrate rust and the paints were considerably more tolerant of a less than perfect surface. The alkyds used today are oleoresinous paints which exhibit some of these tolerant characteristics.

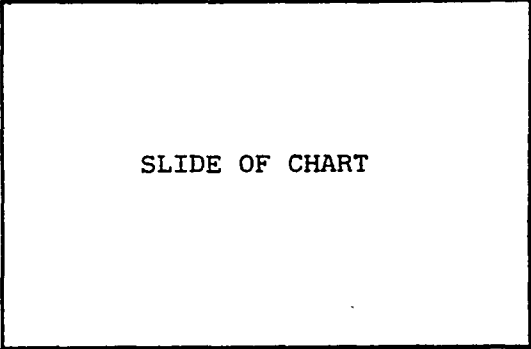
When using the new "exotic" paints, it is critical to follow the manufacturer's data sheet for instructions in handling and application procedures. When exotic paints are used in the same manner as alkyds or other conventional paints, paint failure will usually occur and none of the benefits of the complex formulations will be achieved.

The use of chemicals and synthetic, or man-made, ingredients gives today's paint chemist better control. He can adjust the paint for different application conditions, service exposures, and weather conditions. He can adjust the consistency, improve the durability, add chemical resistance, or add zinc dust to retard corrosion.

These new carefully formulated paints are expensive: \$35 per gallon for aliphatic urethane versus \$10 per gallon for alkyd. However, they can give maintenance free performance over several years, which more than compensates for the high initial cost.

The manufacturer's data sheet, also called the product data sheet, provides information that is essential for the proper application of a paint. In order to use a paint properly, the painter should be familiar with its characteristics. Always consult the product data sheet before applying any paint.

The format of a product data sheet may vary from manufacturer to manufacturer. Some have more information than others, however, all data sheets include a description of the paint, its physical properties, its surface preparation requirements, and the procedure for mixing, thinning, and application.



SLIDE OF CHART

Description of the paint.

- generic type
- color range
- areas of intended or recommended use
- resistance to: chemicals, temperature, or weathering conditions

A paint takes its generic name from the type of resin used in its formulation. Since the characteristics and uses of various resins can be quite different, it is important to know exactly what type of paint is being used. Besides the resin base, the description of the paint may include any special or outstanding characteristics of the paint. These may be such things as: superior water resistance, high chemical resistance, heavy build, high solids, non-toxic, etc.

The manufacturer will also indicate the coating's color range as well as its areas of recommended use. For example, the recommended use for an epoxy-polyamide coating may be as a lining for a chemical storage tank. Often indicated on a data sheet is the resistance of a paint to certain chemicals, temperatures, or weathering conditions.

SLIDE OF CHART

Physical properties.

- number of components (one or two packages)
- percent volume solids
- recommended viscosity
- flash point
- shelf life
- pot life

Certain physical properties of a paint must be known in order to achieve the best coating application. The product data sheet should include information on the following properties:

Number of components. The data sheet should specify whether the coating comes in one package or two packages which must be mixed together. For two-package paints, often the type of curing agent, or catalyst, is indicated, such as "amine type" for an epoxy.

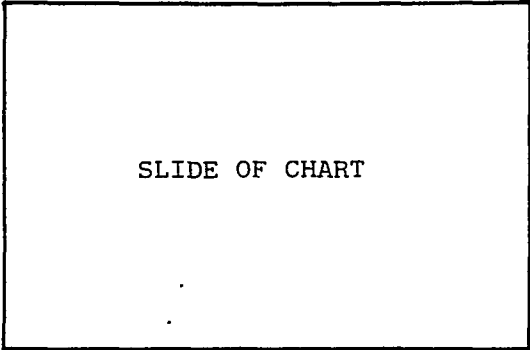
Volume solids. Paints contain solid materials -- the resin, pigments, fillers, and additives -- and solvents which allow the paint to flow. When paint is applied, all of the solvents evaporate leaving only the solids on the surface to form the paint film. Knowledge of the percentage of solids by volume is an important factor in calculating the coverage of a gallon of paint.

Viscosity. Viscosity describes a paint's consistency. It is a measurement of how fast or slow a liquid flows. A high viscosity paint is thicker and flows slower than a low viscosity paint. The viscosity will be specified on the product data sheet as the length of time it should take for the paint to flow through the viscosity measuring cup at a certain temperature. For example, the normal viscosity range of a vinyl acrylic may be indicated as 25 seconds in a Ford Cup #4 at 70°F.

Flash point. The flash point of a paint is the lowest temperature at which the solvent releases enough vapor to ignite in the presence of a flame. This temperature is indicated on the product data sheet in degrees Fahrenheit. The higher this temperature, the safer the paint is to use near an open flame. In some two-package paints, the flash point is different for each component. Once the packages are mixed, the solvents are highly flammable. Measures to avoid sparks and flames should be followed closely.

Shelf life. The shelf life of a paint is the length of time in which a material may be stored at a given temperature and remain in usable condition. For example, certain vinyl coatings may be stored at 70°F for 24 months. Cooler temperatures will increase the shelf life, whereas higher temperatures will severely shorten it. If the paint pigments tend to settle in storage, the shelf life instructions may indicate inverting the containers every 3 to 6 months.

Pot life. The term pot life applies to catalyzed two-package paints. It refers to the length of time in which the paint can be used once the components have been mixed together. The data sheet states pot life in terms of hours of usable life at a given temperature. Since the chemical reaction starts as soon as the two packages have been mixed, care must be taken to avoid mixing paint too long before it will be used. Paint that is allowed to stand beyond its pot life will cure in the container to a hard mass which cannot be sprayed.



SLIDE OF CHART

Surface preparation requirements.

- standard blast grade required
- depth of profile

In order to hold a coating well, the surface must be properly prepared. Early paint failure will result if a paint is applied over a contaminated surface. The product data sheet indicates how clean the surface must be for a specific paint and how to achieve that cleanliness. An example of a typical data sheet specifying the surface preparation requirements for a single package epoxy-ester may be as follows: "Steel surfaces should be given a commercial blast (SSPC-SP6) for a 1½ mil profile. Power tool cleaning or hand cleaning is acceptable. Remove all loose coatings." The data sheet may give different specifications for other substrates and for immersion, high temperature or other special service conditions.

SLIDE OF CHART

Mixing and thinning procedure.

- one-package paints -- type and amount of thinner to be used, if any
- two-package paints -- ratio of catalyst to base paint, induction time, and pot life

For one-package paints, the data sheet will specify the type and amount of thinner to be used. Too much or the wrong kind of thinner will ruin a paint -- directions must be followed closely. Some paints cannot be thinner at all. They achieve their proper flowability by stirring.

For two-package paints, the data sheet will indicate the ratio of catalyst to base such as 1 part catalyst to 4 parts coating material. If the catalyst is pre-measured, that will be specified. Ratio information is essential for proper application and curing. The directions must be followed exactly. The data sheet may also include instructions on mixing technique, when to add the catalyst, and how long to let the coating "sweat in" before application (induction time).

SLIDE OF CHART

Application procedure.

- recommended application method
- recommended equipment type and size
- intercoat and final drying times
- recommended wet and dry film thicknesses

The product data sheet will give the recommended application methods and required equipment. Often detailed information is given regarding the adjustment of spray equipment. For example, for an epoxy-phenolic: adjust air pressure to approximately 50 pounds at the gun and provide 5-10 pounds of pot pressure. Adjust spray gun by opening liquid valve and then adjust air valve to give approximately 3" wide by 10" long oblong spray pattern with best possible atomization.

A thorough data sheet will include the specific types and sizes of the recommended application equipment. The type of spray gun, the sizes of the fluid tip, air cap, ID of the material hose, and the pump pressure may be recommended here for good results.

Read this section for both intercoat and final drying times. These times are always specified at a given temperature, such as: Drying time between coats: 1 to 2 hours @ 75°; Final drying time: 12 to 18 hours @ 75°.

The recommended wet and dry film thicknesses are usually specified here. Where brush application may be used, instructions are given for equipment requirements, technique, mil thickness and drying times.

Special instructions. Any special instructions that appear on a product data sheet should always be followed. They may contain important safety tips or warnings, special mixing, application or clean-up techniques; or information on the cure, recoat, or touch-up times.

DISCUSSION NOTES

In order to make it easier to compare coatings produced by different manufacturers and to assure that the data provided is complete and reliable, the use of a standard paint data/procedure sheet has been recommended. This form clearly states the information required, the proper units in which to express this information, and, when appropriate, the standard test method (as defined by ASTM, SSPC, or the federal government) which the manufacturer should use for testing and describing the results.

Key terms which should be understood by all users, include

<i>% Volume solids</i>	<i>Profile</i>
<i>Viscosity</i>	<i>Induction time</i>
<i>Flash point</i>	<i>Pot life</i>
<i>Shelf life</i>	<i>Dry to recoat time</i>
<i>Gloss</i>	<i>Dry to handle time</i>

Proper curing or hardening of the applied paint film affects its service life. Both overcuring and undercuring may cause paint failures and the correct time varies from paint to paint. The manufacturer's data sheet will indicate "time to cure." This is affected by temperature and humidity and adjustments in the recommended time may be needed for a particular job.

Curing time is critical at two points in paint application, intercoat curing and final curing.

Intercoat curing. Sufficient curing of the undercoat must take place before the next coat is applied. If the undercoat is allowed to cure too long the topcoat will not adhere. The underfilm will be hard and smooth, leaving nothing for the topcoat to bite into. If the undercoat is not sufficiently cured, blisters and lifting may occur due to pressure of the trapped solvents which are trying to escape from the uncured film.

DRIED ≠ CURED

Final curing. Although the terms "cured" and "dried" are often used interchangeably, they do not mean the same thing. A film which is "dry to touch" will not sag, streak, or hold a thumbprint when the thumb is pressed on it with moderate pressure and rotated 90°. A dry film can be handled or walked on but may not have achieved all of its protective qualities.

A coating may be dry to touch but may not be cured. Solvents may be trapped in the interior of the paint film. Only the surface has dried and the hard "skin" has trapped solvents which may cause blistering. A full cure should be obtained before the ship is placed into service.

3 WAYS PAINTS CURE

- Solvent Evaporation
- Air Oxidation
- Chemical Reaction

The resin component of a paint determines how the paint will cure. Basically, there are three types of curing:

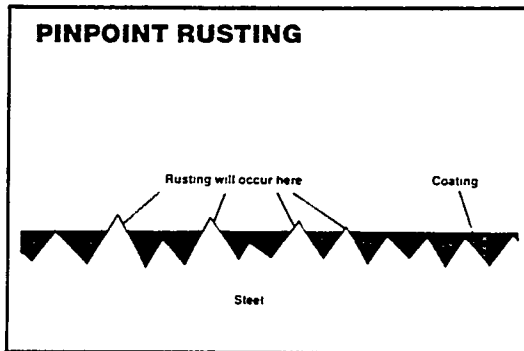
- solvent evaporation,
- air oxidation, and
- chemical reaction.

Solvent evaporation. Lacquers are a class of coatings that cure by solvent evaporation. The solvent completely evaporates as the paint film cures, leaving a film of the resin and pigment on the surface. The most frequently used marine coatings which cure by solvent evaporation are vinyl and chlorinated rubber. They are fast curing, durable, and water resistant. However, their solvent resistance is limited; they can be dissolved by their original solvent. Latex, or water emulsion paints, cure by the same method. In these paints the solvent is water.

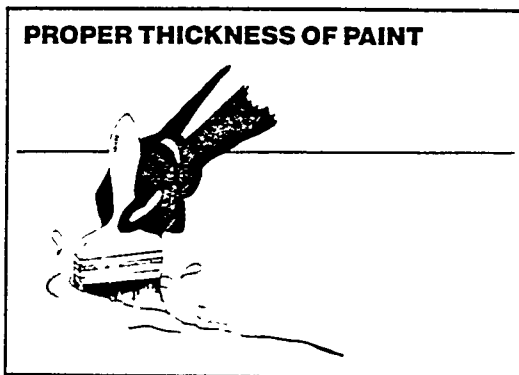
Air oxidation. Paints that cure by oxidation, or air drying, depend upon oxygen to penetrate the paint film after the solvent has evaporated. Alkyds are an example of paints which cure by this method. These coatings are not suitable for use underwater but are often used in the atmospheric zone of a marine structure. There is a limit to the film thickness which can be achieved with this type of paint. If an alkyd is applied too thickly, the solvent will evaporate from the surface, the oxygen will cure the top layer of the paint film, and it will be difficult for the solvent to evaporate from the lower layers of paint. At the same time, oxygen will have difficulty penetrating the rest of the paint film and the coating will not cure properly.

Chemical reaction. Paints that cure by chemical reaction come in two separate packages. These must be combined completely in order to attain the full protective qualities of the paint. Reducing the amount of curing agent added to the base paint does not save money. Instead it leads to an unbalanced coating which cannot perform to expectation. Examples of two-package paints are epoxies and polyurethanes. As a group, these coatings have the best combination of durability and resistance to water, solvents, and chemicals. They are most frequently used on submerged marine structures.

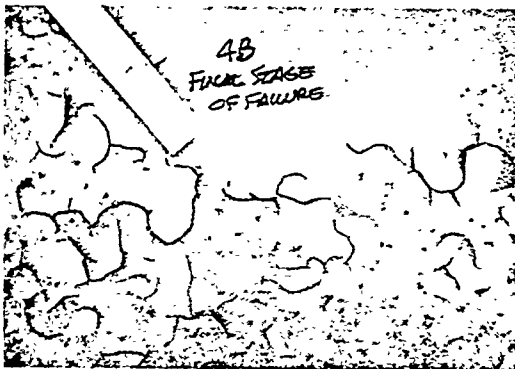
4. FILM THICKNESS IS RELATED TO PAINT PERFORMANCE



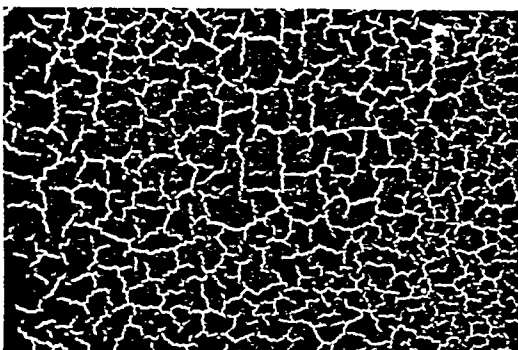
The thickness of the dried paint film on the surface is set by the manufacturer in order to provide the maximum protection. The specified film thickness must be uniform over the entire surface area. If the film is too thin in spots, it may not cover the peaks of the blast profile and pinpoint rusting can occur. A film that is thinner than the required minimum may allow moisture to penetrate to the metal. It provides inadequate protection resulting in a shortened service life.



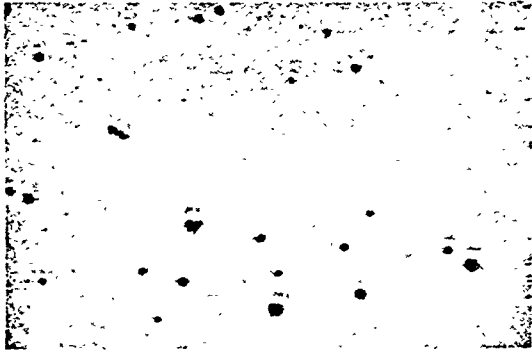
A film that is thicker than required does not necessarily give better protection. In fact, the extra thickness of paint may not even provide protection equal to the specified film thickness. A coating which is too thick may



- lose adhesion and peel away from the surface;



- mud crack (a common problem with heavily applied inorganic zinc); or



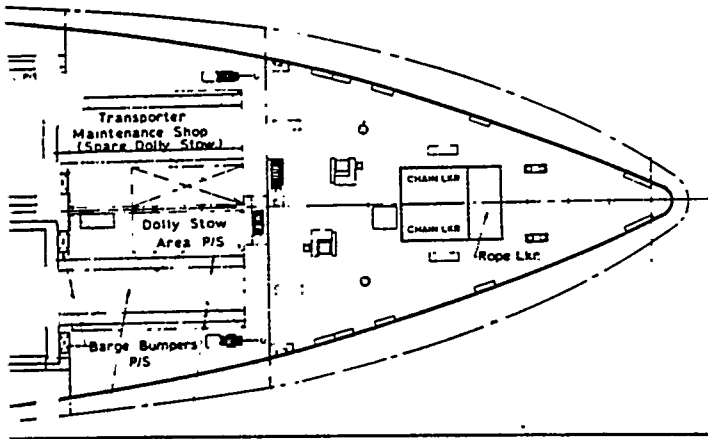
- cure improperly (because it cannot dry internally) and blister or peel.

Coating thickness is measured in mils. One mil is one-thousandth of an inch (.001"). If the specification uses metric units, thickness will be expressed in microns. A micron is one thousandth of a millimeter, twenty five times smaller than one mil. Because these are such small measurements, it takes a great deal of skill to obtain the required paint thickness.

PART A

PLANNING NOTES

UNIT III ACHIEVING THE MAXIMUM PAINT SERVICE LIFE



Learning Objectives

After discussing this study unit, trainees should be able to:

1. Explain the importance of the information provided in the manufacturer's data sheet:
 - catalyst
 - DFT
 - dry to handle
 - dry to recoat
 - flash point
 - gloss
 - induction time
 - mil
 - mistcoat
 - pot life
 - profile
 - shelf life
 - tiecoat
 - viscosity
 - volume solids
 - WFT
2. Discuss the relationship of film thickness to paint performance.
3. Describe how proper curing affects the service life of a paint.
4. Measure WFT.
5. Predict the dry film thickness from wet film thickness measurements.

Notes to the Instructor

1. THE WET FILM THICKNESS GAGE (p. A.29)

This gage is a very important tool for the painter. It will help him to adjust his gun and set his speed for that job.

Emphasis should be placed on:

- the need to measure WFT immediately, before the solvent has time to flash off; and
- the difficulties of using this gage when applying inorganic zinc and other heavily pigmented paints.

2. TYPOGRAPHICAL ERROR, p. A.31, Step 2 SHOULD READ:

962.4 sq. ft. \div 3 mils = 320.8 ft. @ 3 mils

Replace the - sign with a \div sign.

Equipment/Aids

Slide projector and screen
WFT gage

Standard Data Sheet (Shipbuilders & Marine)
Manufacturer's data sheets in current use

Discussions/Group Work

Topic 2. Standard paint data sheet. Compare the proposed standard paint data sheet to those provided by manufacturers of paints currently used in your yard. Review items that are critical for application of the products on your current job.

Topic 5. Determining DFT from WFT. After reviewing the example given in the text, ask the trainees to individually calculate the DFT based on 4 mils WFT and a paint with 60% volume solids.

Unit Quiz

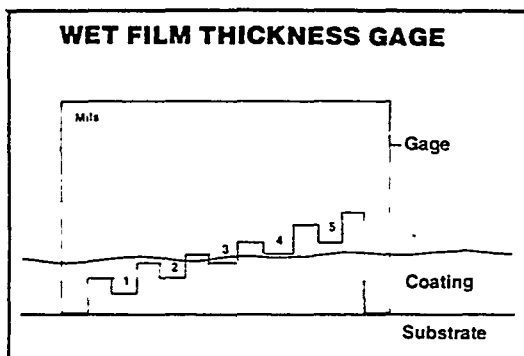
An 18-question quiz is provided with this unit. Duplicate copies for each participant. Allow 10 minutes to complete the quiz. Discuss each question and answer thoroughly.

Answers to Unit Quiz A-III:

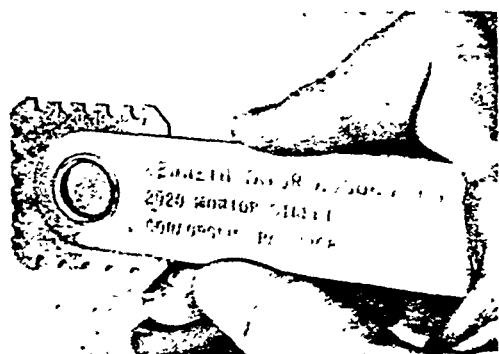
- | | | |
|------|---------|-------|
| 1. D | 7. B | 13. T |
| 2. E | 8. B, D | 14. F |
| 3. C | 9. D | 15. F |
| 4. A | 10. B | 16. T |
| 5. B | 11. B | 17. F |
| 6. B | 12. F | 18. T |

5. PREDICTING THE DRY FILM THICKNESS DURING PAINT APPLICATION

Dry film thickness (DFT) is the thickness of the cured paint film on the surface, once all of the solvent has evaporated. One way to predict the final dry film thickness is by measuring the wet film thickness (WFT) as the coating is being applied. The operator can adjust his gun and the speed of his work so that the specified thickness for that material and surface will be obtained. It is important to take the WFT measurement immediately after spraying a surface, before the solvents can evaporate. Measuring the wet film thickness after the solvents evaporate will result in an inaccurate reading, one that is lower than actual.



The WFT is easily measured using a wet film thickness gauge which looks like a comb with notches and legs of different lengths. Press the gauge against the painted surface. Some of the legs penetrate the paint, while others do not. Read the first clean leg, the first leg that has not penetrated the paint. This reading indicates the maximum possible thickness of the paint film. The true WFT is a value between the clean leg and the next closest leg which is covered with paint. In the illustration, the WFT would be approximately 3.5 mils.



Proper measurement of WFT involves the following steps:

- Step 1. Take the WFT reading immediately after paint application.
- Step 2. Use the WFT gauge on a flat surface. Both ends must be firmly touching the surface to get an accurate reading.
- Step 3. On a vertical surface, such as a bulkhead, hold the gauge in a north-south position (vertical) with the longer legs at the top. This prevents the paint from running down over the longer legs and giving a false reading.
- Step 4. On a pipe, the gauge should be placed along the length; be certain that both legs are touching the surface.
- Step 5. Lift the gauge from the surface without sliding. Slipping or sliding will give a false reading because extra paint will be picked up on the legs.

Step 6. Use only a clean and dry gauge. Clean the gauge after each reading. Dirt on bottoms of the legs can add to their length and give readings that are too low for what actually has been applied.

To calculate the expected DFT you must have two pieces of information: the measured WFT and the percentage of volume solids in the paint, which is on the product data sheet. Simply multiply these two numbers to find the expected DFT. The following example shows how this is done.

Determining DFT from WFT:

What is the expected DFT if a paint containing 50% solids by volume is sprayed to a wet film thickness of 4 mils?

Step 1. WFT X % volume solids = DFT
 4 mils X 50% = DFT

Step 2. Convert the percent to a decimal:
 50% ÷ 100 = .50
 4 mils X .50 = 2 mils DFT

In this example the DFT is one-half of the WFT. Half of the paint was made of solvents which evaporated leaving a dry film with half the thickness of the wet film. If a paint containing 60% solids by volume were sprayed on at four mils, what DFT would be expected?
(Answer: 4 mils X .60 = 2.4 mils DFT)

Knowledge of the percent of solids by volume in a can of paint is also useful for calculating the amount of surface coverage. In theory, one gallon of 100% solids paint would cover 1,604 square feet at a thickness of 1 mil. If the paint contains only 50% solids by volume, it has only half as much film forming material and will cover only 802 square feet. (To estimate the coverage of one gallon of paint at one mil applied thickness, multiply 1,604 sq. ft. by the percent volume solids.) If a painter has covered a larger area, it is certain that the paint film is too thin.

Calculating paint coverage in this way is only an estimate. Practical circumstances must be taken into account to determine the true coverage. No painter can get every drop of paint out of the container, nor can he avoid leaving some material in a brush, roller, or spray pot. Paint loss also occurs during spraying due to air movement or overspray. Losses will vary from job to job and between painters. Practical coverage also depends on the condition or type of surface that is coated. For structural steel, the practical coverage will be about 20% less than the theoretical coverage. For covering pitted steel surfaces the percentage will be even greater because there is more surface area to be covered. In outdoor shipyard application, paint loss may be as high as 20 to 50%.

To calculate the practical coverage of one gallon of paint with 60% volume solids, at 3 mils, with a 20% paint loss, follow these steps:

Step 1.

$1604 \text{ sq.ft.} \times .60 \text{ volume solids} = 962.4 \text{ sq.ft.}$
@ 1 mil

Step 2.

$962.4 \text{ sq. ft.} \div 3 \text{ mils} = 320.8 \text{ sq. ft.}$ @
3 mils

Step 3.

$320.8 \text{ sq.ft.} \times .20 \text{ paint loss} = 64 \text{ sq.ft. loss}$

Step 4.

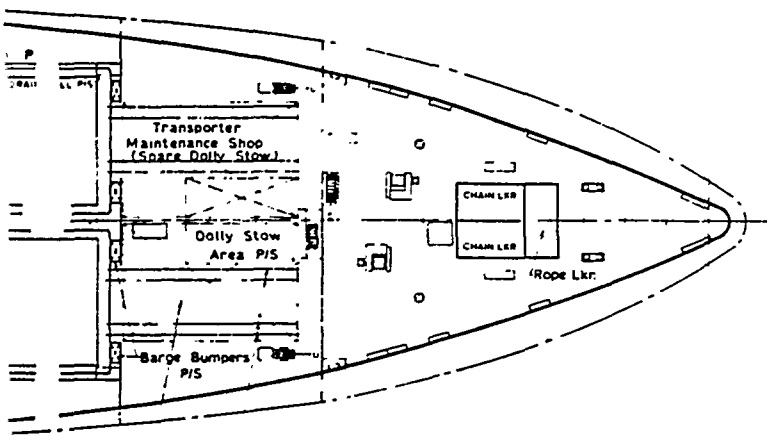
$320.8 \text{ sq.ft.} - 64 \text{ sq.ft.} = 256.8 \text{ sq.ft. practical coverage.}$

Under certain circumstances, two coats of paint do not bond well and will require special application techniques to obtain adequate intercoat adhesion. Tiecoating and mistcoating are two such techniques.

Tiecoating is the application of a thin coat of a different type of paint to promote intercoat compatibility. A tiecoat is a separate adhesive coating on the top of the primer applied approximately $\frac{1}{2}$ mil thick.

Mistcoating is the application of a heavily thinned layer of the undercoat. Approximately 10 percent solids and 90 percent solvent is recommended. It is used to "re-flow" or "solvate" the previous coat of paint which may have overcured, leaving the surface too glossy for adhesion. The high solvent content of the mistcoat dissolves a thin surface of the primer and makes it more suitable to hold a second coat. The mistcoat is not a coat in itself the way a tiecoat is.

Mistcoating is also used when coating over a porous-type substrate such as inorganic zinc. The mistcoat saturates the pores underneath and prevents pinholing and bubbling of the tiecoat.



PART A

QUIZ

UNIT III ACHIEVING THE MAXIMUM PAINT SERVICE LIFE

NAME:

DATE:

INSTRUCTOR:

GRADE:

Circle the most correct answer.

1. Manufacturer's data sheets

- A. must be consulted only before applying a paint.
- B. are merely sales devices which list the prices of the paint.
- C. do not vary among manufacturers and all have the same amount of information.
- D. must be consulted prior to any painting work, even before opening a can of paint.

2. The viscosity of a paint is affected by

- A. temperature and stirring.
- B. thinning and stirring.
- C. catalyzation or induction time.
- D. thinning only.
- E. A, B & C

3. The flash point of a paint refers to

- A. the highest temperature at which a material will ignite when a flame is present.
- B. the amount of flammable material.
- C. the lowest temperature at which a material will ignite when a flame is present.
- D. the mixture of solvents in two-package paints.

4. The pot life of a paint

- A. refers to the length of time, after mixing, that a catalyzed paint may be used.
- B. refers to the length of time a material may be stored and remain in usable condition.
- C. refers to both one and two-package paints.
- D. remains indefinite if the temperature is cool enough.

5. The percentage of volume solids in a paint

- A. is usually 50% in every type of paint.
- B. refers to the amount of film forming ingredients.
- C. does not affect the final dry film thickness.

6. The thickness of the dried paint film on the surface
- A. is usually one half the wet film thickness.
 - B. must be uniform over the entire area.
 - C. will provide more protection if it is higher than the specified thickness.
 - D. can be under the specified thickness in some spots, as long as the peaks of the blast profile are covered.
7. An undercoat of paint
- A. can never cure too long.
 - B. must fully cure prior to the application of the next coat.
 - C. must be only dry to touch.
 - D. cannot blister or lift if the surface film has cured.
8. Two methods for promoting good intercoat adhesion are
- A. overcoating
 - B. mistcoating
 - C. raincoating
 - D. tycoating
9. The manufacturer's data sheet will probably not provide information on
- A. mixing and thinning procedures of two-package paints.
 - B. depth of profile.
 - C. air pressure at the spray gun nozzle.
 - D. blast nozzle pressure for the surface preparation requirements.
10. The thickness required for a certain coating and type of job is usually called out in
- A. milliliters
 - B. mils
 - C. millimeters
 - D. milligrams
11. If the induction time is exceeded
- A. the paint is ruined and must be thrown out.
 - B. the amount of work time the paint applicator has is shortened.
 - C. the paint will be too thin causing sags.
 - D. the paint should be thinned by 20% before spraying.

Check the correct answer.

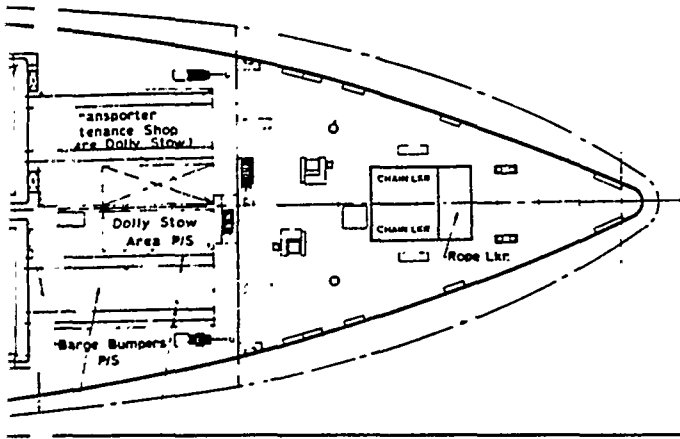
- | | <u>TRUE</u> | <u>FALSE</u> |
|--|-------------|--------------|
| 12. "Exotic" paints, although more expensive, can be handled and applied in the same manner as alkyds and other conventional paints. | [] | [] |
| 13. The viscosity of a paint describes how fast or slow a material flows. | [] | [] |

	<u>TRUE</u>	<u>FALSE</u>
14. If a paint has dried "to touch," it has fully cured.	[]	[]
15. Curing time is only critical in the final stage — if the topcoat is cured, the undercoats will also be cured.	[]	[]
16. The final DFT of a paint can be predicted during paint application.	[]	[]
17. Because high performance coatings contain a blend of many synthetic ingredients, it is possible to use any thinner available in the shop.	[]	[]
18. Shelf life is affected by the storage temperature.	[]	[]

PART A

PLANNING NOTES

UNIT IV FAILURE RESULTING FROM PAINT FILM DEFECTS



Learning Objectives

The objective of this unit is to enable painters and their supervisors to identify common types of film defects, understand their relationship to paint failure, and know how to correct them in the field. The specific causes of these defects which may be related to proper adjustment of spray equipment and good operator technique are covered in Part C of this training manual.

After discussing this study unit, trainees should be able to:

1. Explain how film defects lead to premature paint failure.
2. Identify the most common film defects from sight.
3. Discuss the ways to remedy film defects.
4. Explain the following key terms:
 - blistering
 - decomposition
 - defect
 - delamination
 - deterioration
 - failure
 - scaling

Notes to the Instructor

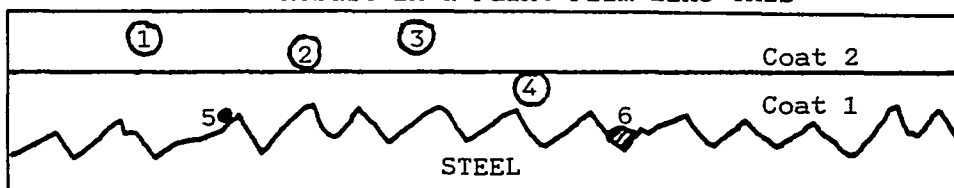
No organic paint film is 100% impermeable nor is any steel surface, no matter how well prepared, 100% contaminant free. The elements which contribute to paint failure are always present. It is our challenge to minimize their occurrence through proper surface preparation and paint application technique.

The following model will help to explain how paint failures may occur:

FACTS:

1. All organic coating films allow some penetration of moisture vapor.
2. When steel rusts, the rust (iron oxide) takes up greater space (is larger in volume). This may cause lifting of the paint film.
3. Minute amounts of air can be trapped in the profile of blasted steel.

Inadequate Coating Work Can
Result in a Paint Film Like This



- 1 = Solvent - trapped in film, unevaporated
- 2 = Dirt/contamination in film from airborne sources
- 3 = Traces of resin, unreacted (chemically converted coatings)
- 4 = Traces of catalyst, unreacted (chemically converted coatings)
- 5 = Contaminant on surface
- 6 = Air in profile, usually a problem with thick coatings

PROBLEMS:

As moisture penetrates the film, it can combine with the solvent, or resin, or catalyst, swelling and causing a blister. If the moisture combines with the contaminants, an electrolyte will be formed creating an environment which accelerates corrosion. If the water vapor reaches the air pocket on the clean steel, it may condense due to the temperature difference between the coating and the steel. This water on the surface can cause under-film corrosion. Lifting and rupture type failures may occur.

AVOID THESE PROBLEMS:

- Allow the full induction time for chemically converted coatings as recommended by the manufacturer. An adequate induction period will reduce the possibility of traces of resin and catalyst remaining in the film. Mix thoroughly and agitate as recommended.
- Pay attention to curing time. Allow sufficient time, at the temperature and humidity on your job site, to allow for complete solvent evaporation. This is critical in prime coat and topcoat applications. Consider the use of heaters to speed curing and assure that the solvents are driven off.
- Check compressors and pump filters regularly to reduce surface contamination.
- Check viscosity. The wetting characteristic of the primer is important. A film that is applied too dry will not flow out into the surface profile and other irregularities of the steel. While the application of fewer, thick coats to achieve a specified mil thickness may seem cheaper than several thin coats, in critical areas such as immersion and tank linings this can be more costly in the long run.

Equipment/Aids

Slide projector and screen

Optional: Photographs of problem areas on your ship
Photographs of past failures
Plates sprayed to recreate types of defects

Reference

ASTM D 714-56 (1974) Evaluating Degrees of Blistering of Paints. This photographic reference standard describes the size and density of paint blisters for use in a specification of performance.

Discussion

Ideally, no defects should exist in a paint film; however, this is impractical in shipyards and the establishment of tolerance limits for accepting a coating job must be defined by the owner and seller in advance. Using a current job as an example, discuss the acceptance criteria established for defects such as blisters, pinholes, and overspray. Reference ASTM D 714-56 as appropriate. Bring photographs to the classroom.

Unit Quiz

A 10-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz A-IV:

- | | | |
|------|-------|-------|
| 1. F | 6. D | 11. T |
| 2. T | 7. A | 12. F |
| 3. T | 8. E | |
| 4. F | 9. B | |
| 5. T | 10. C | |

FAILURE RESULTING
FROM PAINT FILM DEFECTS**PAINT**

All paints and coatings eventually deteriorate naturally. After many years of exposure to rain, sun, and temperature cycles even the best paints begin to fade, crack, or peel. In the early stages of normal decomposition, the appearance of the paint may be changed but its performance as a protective barrier is not affected. Color changes and light chalking may be unsightly but they do not change the ability of the coating to perform.

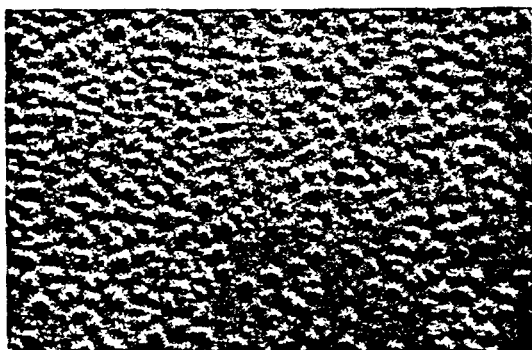
As normal deterioration progresses, the coating film will begin to show signs of wear and loss of ability to protect the surface. These signs or defects indicate that the adhesion or continuity of the paint film is in doubt and that the barrier may no longer be able to protect the substrate against corrosion attack. Left uncorrected, even the smallest defects can lead to serious failures of the coating.

Many of the defects which normally would appear after many years of service can be seen immediately after a coating is applied, after curing, or after only a few months of service. These defects may be the result of improper surface preparation, improper mixing, or improper paint application. They lead to premature paint failures and must be remedied before catastrophic failure and damage to the surface occurs.

Discontinuities in the paint film are one type of defect. These include sags, streaks, pinholes, fish eyes, and orange peel. Loss of adhesion is another category of defect which exposes the substrate. Small amounts of flaking and scaling or fine cracks in the film allow corrosion to undercut the solid parts of the paint film, causing large-scale peeling and delamination.

Elimination of every defect on a coated surface is not always practical in shipyard work. Certain service areas are less critical and a small number of defects may be tolerated without risk of catastrophic paint failure. The permissible number and size of defects must be agreed upon by the owner, paint department, and inspector in a pre-job conference.

Film defects are caused by a great variety of factors, among which are improper application techniques, faulty equipment, incorrect spray viscosity, or contaminated substrates. Most defects can be prevented from the outset. Once they do appear, they can often be remedied without the necessity of having to rework the entire area. Following is a list of some commonly experienced film defects, their recognizable characteristics, and suggested remedies.

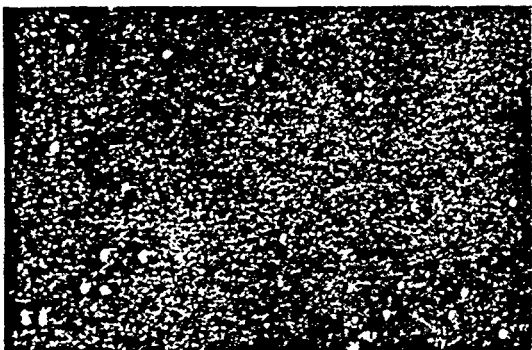


Cratering, Pitting

Appearance: Small uniform indentations in the film.

Cause: Air pockets trapped in wet film during application.

Remedy: Sand or blast to a smooth finish. Apply additional coats over the affected area.



Pinholing

Appearance: A tiny but deep hole in the film where the steel or a preceding coat of paint is exposed. Pinholes on the primer can be detected with a special electric current instrument. They are too small to be seen with the unaided eye but show up under 5-power magnification.

Cause: Insufficient paint atomized; coarse atomization; settled pigment.

Remedy: Brush pinhole areas and apply an additional coat of paint.

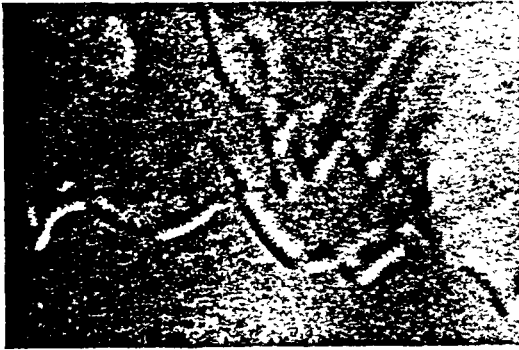


Fish Eyes

Appearance: Separation or pulling apart of the wet film. Previous finish or substrate can be seen in spots.

Cause: Improper surface cleaning; spraying over oil, dirt, silicone; incompatible coatings.

Remedy: Blast or sand, followed by a brush coat. Spray an additional coat over the area.

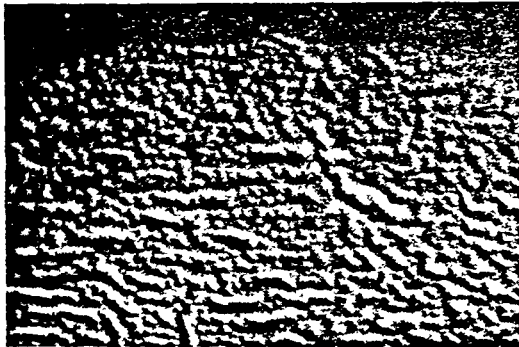


Runs and Sags

Appearance: Excessive flow of material causing slippage of paint, having the appearance of curtains.

Cause: Spray gun too close to work; too much thinner; too much paint applied; application over a hard or glossy finish.

Remedy: Brush out to remove excessive material before area becomes dry to touch. After runs and sags have cured, remove by sanding and apply an additional coat.

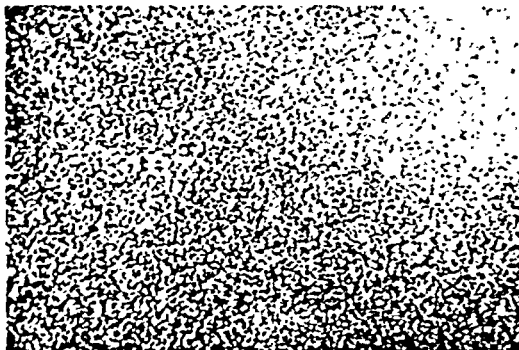


Wrinkling

Appearance: Rough, crinkled surface

Cause: Second coat dries before first; too much paint applied; application over glossy finish; painting in hot sun or over too cold a surface.

Remedy: Remove wrinkled layers, by scraping or sanding. Repaint, avoiding direct, hot sunlight or temperatures below 40°F.



Overspray, Dry Spray

Appearance: Dry, flat, pebbly appearance.

Cause: Too rapid solvent flash-off -- particles reaching surface are not wet enough to flow together; paint particles fall to surface outside the spray pattern; gun held too far from surface.

Remedy: Before cure remove by brushing with a dry brush followed by solvent wiping. After cure, sand and apply a second coat.



Dirt Under Finish

Appearance: Foreign particles dried in the paint film.

Cause: Improper cleaning of surface or spray gun; dirty work area.

Remedy: In most cases, sanding and recoating is sufficient. Blasting may be indicated in extreme cases.

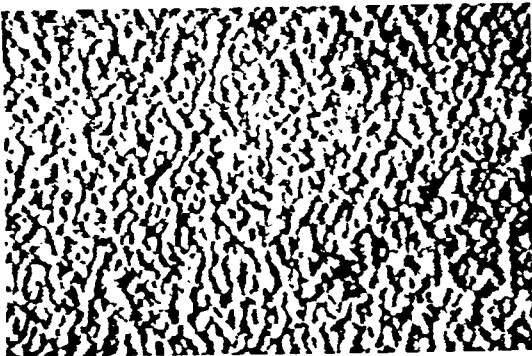


Blistering

Appearance: Small swelled areas or broken edge craters.

Cause: Oil or moisture left on steel surface; improper undercoat or topcoat curing.

Remedy: For unbroken blisters, light sanding followed by repainting will correct the damaged areas. If the blisters have broken, apply an additional coat of paint.

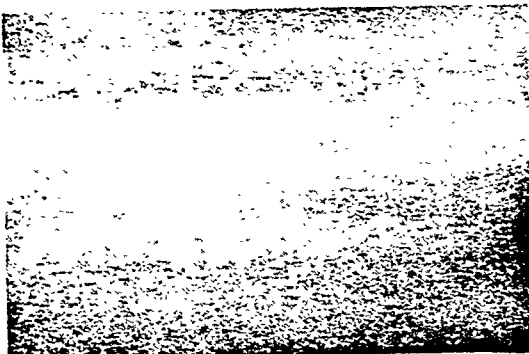


Orange Peel

Appearance: Slight hills and valleys in the paint film, resembling the skin of an orange.

Cause: Air pressure too low causing improper atomization; material viscosity too high; solvent evaporates too fast; gun too close to surface.

Remedy: Sand the area smooth and apply a second coat.

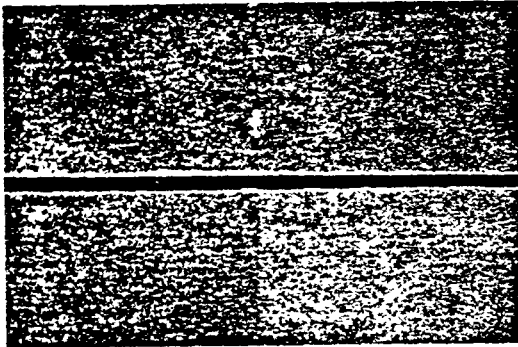


Blushing

Appearance: Finish is flat and has a milky appearance.

Cause: Fast thinners in high humidity, unbalanced thinners; condensation on old surface.

Remedy: Sand area and respray, after adding retarder to the thinner used.

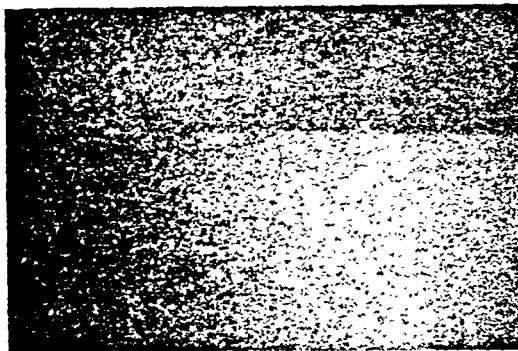


Fading

Appearance: Color changes or irregularities.

Cause: Moisture behind paint film can leach the pigment; ultra violet degradation.

Remedy: Repaint once the color has faded. Correct any possible sources of moisture.

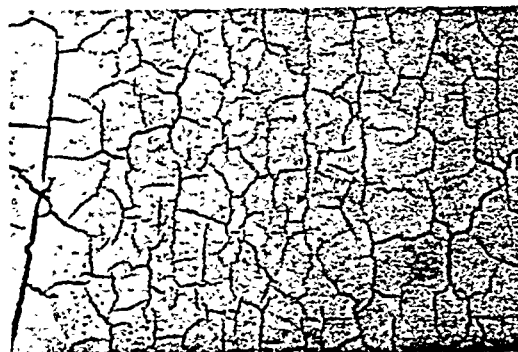


Uneven Gloss

Appearance: Non-uniform sheen, shiny spots.

Cause: Uneven film thickness; moisture in paint film and temperature variation during drying; painting over paint film that is too wet or soft.

Remedy: Allow flattened paint to dry hard and apply another finish coat, when moisture is not present and temperature changes are less likely.

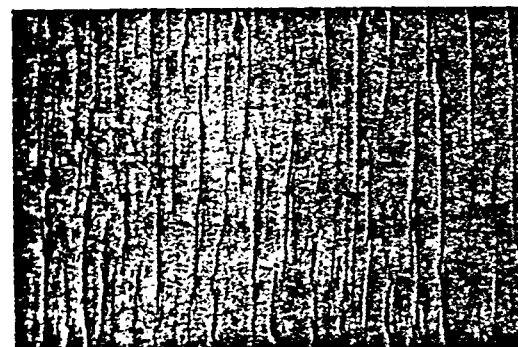


Checking

Appearance: Short, narrow breaks in top layer of paint.

Cause: Loss of paint film elasticity; excessive paint applied; surface or surrounding temperature too high during application.

Remedy: Remove paint down through the checked film and repaint.

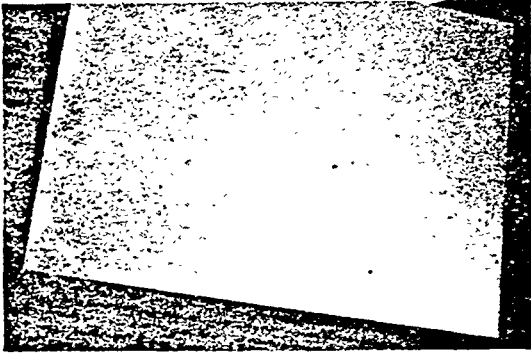


Cracking

Appearance: Deep breaks in the paint which may go down to the substrate.

Cause: Shrinkage of the film; excessive thickness of paint film (especially zinc-rich); improper exposure to high temperature or sun.

Remedy: Remove coating completely and repaint.

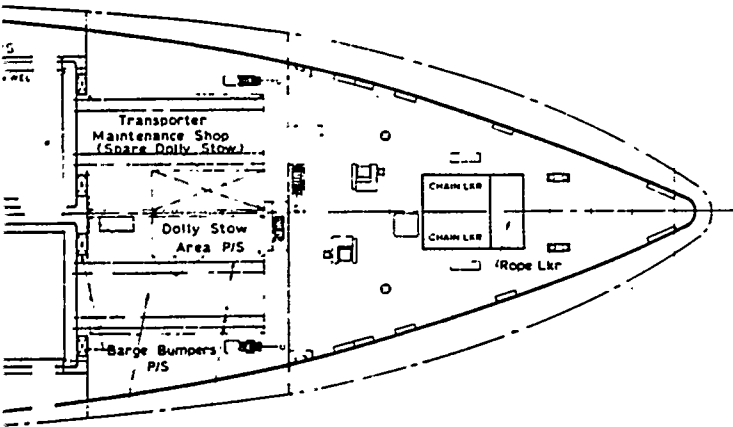


Cobwebbing

Appearance: Stringy, thin paint particles on the surface; similar to "fingers" or "cobwebs."

Cause: Solvent evaporates before paint is deposited on the surface, especially when using paints with fast solvents, such as vinyl or chlorinated rubber.

Remedy: Use a slower solvent, especially in hot weather.



PART A

QUIZ

UNIT IV FAILURE RESULTING FROM PAINT FILM DEFECTS

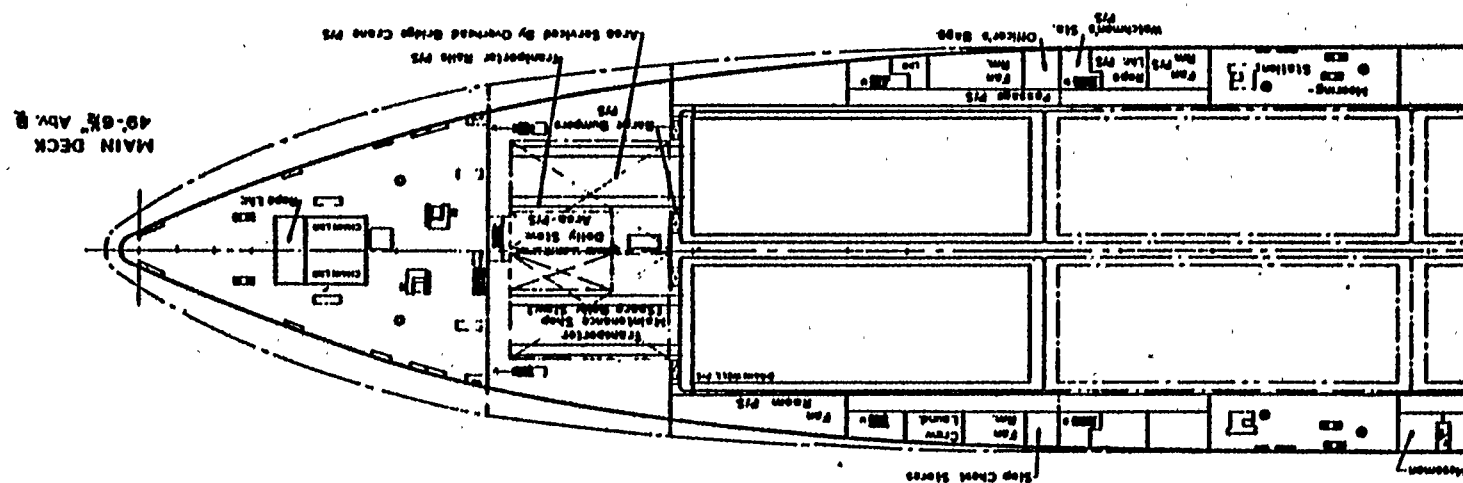
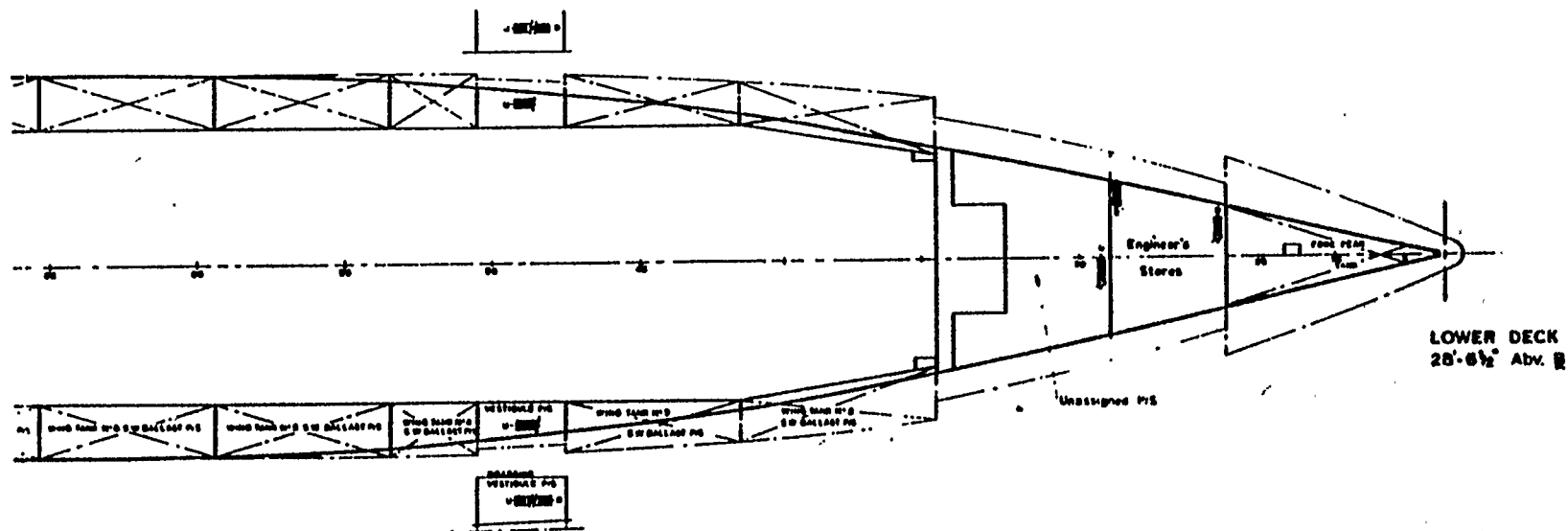
NAME: _____ DATE: _____ INSTRUCTOR: _____ GRADE: .

Check the correct answer.

- | | <u>TRUE</u> | <u>FALSE</u> |
|--|-------------|--------------|
| 1. All paint film defects can be spotted prior to putting the ship in service. | [] | [] |
| 2. A small defect, even the size of a pinpoint, can lead to a serious attack of corrosion. | [] | [] |
| 3. A paint has failed when it can no longer serve as a barrier against corrosion attack. | [] | [] |
| 4. All failures of the sophisticated paints can be prevented if proper surface preparation, mixing, and application techniques are followed. | [] | [] |
| 5. All paints and coatings will naturally deteriorate, with exposure to rain, sun, and other weathering elements. | [] | [] |
| 6. Sags may lead to failure at the points where the slipped paint is too thin. | [] | [] |
| 7. Flaking, peeling, pitting and delamination are all examples of loss of paint adhesion. | [] | [] |

Matching: Identify the film defects from Column 2, based upon the descriptions of their appearance in Column 1.

- | <u>Column 1</u> | <u>Column 2</u> |
|---|------------------|
| 8. _____ Dry, flat, pebbly appearance. | A. Blushing |
| 9. _____ Flat finish with a milky appearance. | B. Fish Eyes |
| 10. _____ Slight hills and valleys, resembling the skin of a citrus fruit. | C. Runs and Sags |
| 11. _____ Separation of the wet film. | D. Overspray |
| 12. _____ Appearance of curtains and paint slippage due to excess flow of material. | E. Orange Peel |



D A D T D

**SURFACE PREPARATION:
THE KEY TO**

PAINT AND SURFACE PREPARATION
TRAINING PROGRAM FOR SHIPYARD PERSONNEL

Part B: SURFACE PREPARATION: THE KEY TO COATING PERFORMANCE

Unit I: The Importance of Surface Preparation

- TOPICS:
- 1) Surface Cleanliness is Essential for Paint Adhesion
 - 2) Anchor Pattern Improves Paint Bonding
 - 3) Surface Conditions Requiring Special Work
 - 4) Setting Standards for Blast Cleaned Steel
 - 5) Standard Grades for Blast Cleaned Steel
 - 6) Using the SSPC Standards

Unit II: How to Choose the Proper Method for Surface Preparation

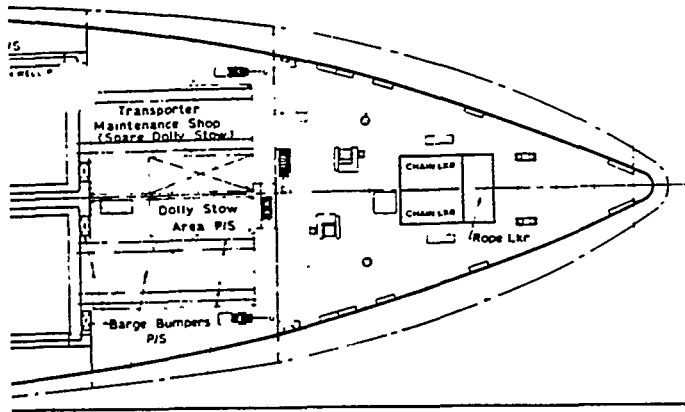
- TOPICS:
- 1) Many Surface Preparation Methods are available to Shipyards
 - 2) Six Factors Determine the Best Choice
 - 3) Blasting is Ideal for Most High Performance Coatings
 - 4) How Blasting Works to Clean the Surface

UNIT III: Equipment Set-up for Nozzle Blasting Efficiency

- TOPICS:
- 1) Basic Nozzle Blasting Set-up
 - 2) The Air Compressor: The Power Source
 - 3) Air Pressure and Air Volume Control Efficiency
 - 4) Choosing Hose to Reduce Friction Loss
 - 5) Blasting Has Limitations
 - 6) Nozzle Size Affects Work Efficiency
 - 7) Four Characteristics Determine Abrasive Cleaning Rate
 - 8) Tips for Maintaining Blasting Efficiency

UNIT IV: Efficient and Safe Practices for Surface Preparation

- TOPICS:
- 1) Good Blasting Technique
 - 2) Determining the Size of the Area to be Blasted
 - 3) How to Measure Air Pressure
 - 4) How to Maintain the Quality of the Air Supply
 - 5) Keeping Abrasives Contaminant - Free
 - 6) Safe Practices



PART B

PLANNING NOTES

UNIT I IMPORTANCE OF SURFACE PREPARATION

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Describe 5 types of surface contamination which affect paint bonding.
2. Explain the importance of surface profile and how it is measured.
3. Identify at least 4 surface conditions which stand in the way of good paint film formation.
4. Demonstrate the use of the SSPC pictorial standards for blasted steel.
5. Explain the following key terms:

- | | |
|--------------------|----------------------|
| - adhesion | - near-white blast |
| - bonding | - profile |
| - brush-off blast | - surface comparator |
| - commercial blast | - white metal blast |
| - mill scale | |

Equipment/Aids

Slide projector and screen
SSPC standards

Optional: NACE standards
SNAME standards

Discussions/Group Work

Three discussion areas are suggested. If you choose to include these in your lessons, be certain that the necessary materials and equipment are available.

Topic 1. Recognize mill scale. Five slides are included showing different views of mill scale. Provide actual unblasted steel coupons with mill scale and blasted coupons with mill scale intact. Trainees must learn to identify mill scale and to distinguish between a commercial blast grade, which must be mill scale free, and a sweep off blast which permits mill scale.

Topic 2. Measuring surface profile. Demonstrate the use of the surface profile comparator and needle gage. You will need comparator, batteries, discs, blasted metal panels, needle gage, glass for zeroing (a window pane is fine). Impress upon trainees the importance of using the

proper disc. No discs currently exist for mineral grit. Don't be fooled by the term grit. The comparator grit disc is for use with metallic grit only. Use the sand disc when observing surfaces blasted with abrasives such as Black Beauty, Green Diamond, and other boiler slags.

Be certain to record each individual's readings. Compare and discuss the accuracy of readings made on the same plate with the two different instruments.

Topic 6. Judging the square inch rule. A slide is included for this exercise.

Unit Quiz

An 18-question quiz is provided with this unit. Allow 10 minutes to complete the quiz. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz B-I:

- | | | | |
|------|-------|-------|-------|
| 1. A | 6. D | 11. T | 16. F |
| 2. D | 7. B | 12. F | 17. F |
| 3. C | 8. B | 13. F | 18. T |
| 4. D | 9. T | 14. F | |
| 5. A | 10. F | 15. T | |

UNIT I
IMPORTANCE OF
SURFACE PREPARATION

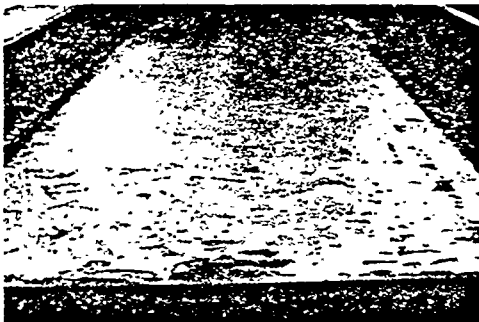
1. SURFACE CLEANLINESS IS ESSENTIAL
FOR PAINT ADHESION

Cleanliness is essential for a steel surface to hold a coating. Paint will not bond, or adhere, to a steel substrate that has rust, dirt, or oil. If paint is applied over such contaminants, early paint failure will result.

Oil-based paints are slow drying and can penetrate rust and dirt to some degree. They are more tolerant of a poorly prepared surface. Years ago, when alkyds, red lead primers, and natural oils were the major paints used in shipyards, surface preparation did not require as much attention as it does today.

With the use of "exotic" high performance paints, such as inorganic zinc, epoxies, and urethanes, which are very sensitive to dirt and rust, all foreign matter must be completely removed from the surface. A completely "clean" surface is free from contaminants such as:

- mill scale,
- rust,
- flash rust,
- dirt,
- salts,
- oil and grease, and
- dead paint.



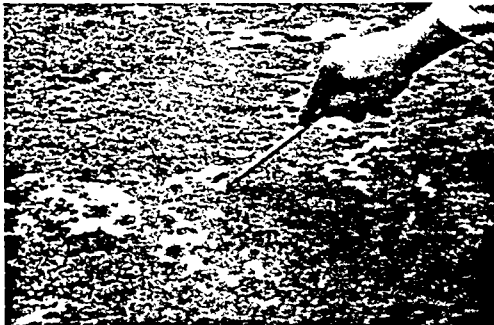
Mill scale is a residue which forms on the surface of the steel as it is hot rolled. As the steel cools, this residue of iron oxides forms a tight "skin" or "crust" over the entire surface. The thicker the steel, the thicker this layer will be. Depending upon the quality of the metal and the rolling conditions, mill scale may vary from 0.002 inches to 0.20 inches.

Mill scale has a bluish, somewhat shiny appearance which may be difficult to distinguish on new or partially blast cleaned steel. It is a difficult contaminant to remove but modern paints require the surface to be completely free of mill scale.

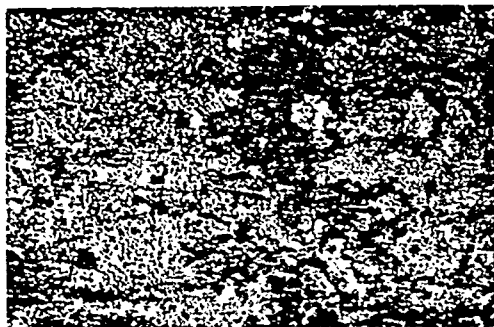
On new steel, mill scale is tightly adhered to the surface.



After exposure and handling, the scale will begin to pop and it can be penetrated.



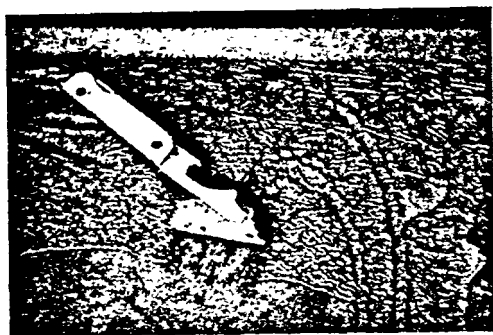
Continued exposure leads to widespread popping and cracking which allows rust to form on the steel.



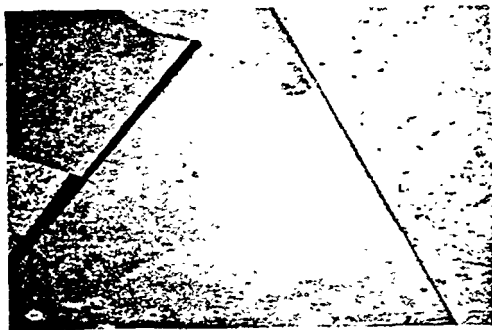
If mill scale has been painted over, it will break the coating and pitting will occur.



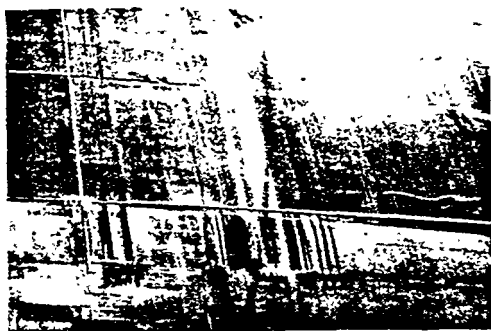
Rust cannot be penetrated by most paints. painting over rust will give an uneven coating with exposed areas of metal where further corrosion can take place. Flash rust is a light layer of rust which appears on cleaned steel soon after exposure to the air. In humid areas, the steel may rust within one hour of blasting.



Dirt and dust particles on the surface prevent the application of a smooth, uniform coat of paint. Loose dirt should be brushed or vacuumed off the surface. Heavy soil and grime will require chemical or steam cleaning.



Salts of various chemicals accelerate the rate at which corrosion will occur. If paint is applied over salt, corrosion cells develop and rusting will take off rapidly from these points. In maintenance and repair (M & R) work, salts are likely to be trapped in pits and crevices and particular attention must be given to cleaning these areas.



Oil and grease prevent good paint adhesion and must be completely removed from the surface. Smoke from welding and inspection markings may leave an oily residue which must be thoroughly removed.



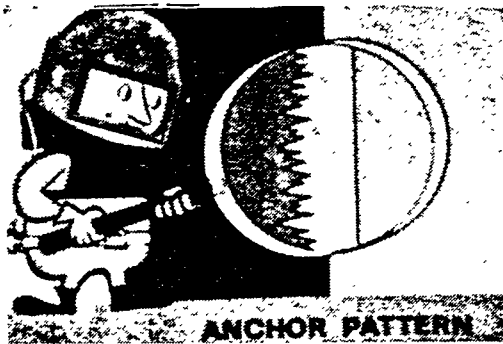
Dead paint that is loose, cracked, or flaking must be removed totally before repainting. Old layers of unsound or dead paint will lift from the surface, cracking the new coat. This can result in peeling, or delamination, of large layers of paint.



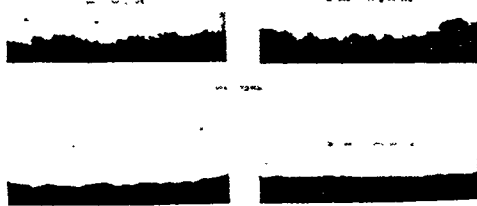
Surface cleanliness is also critical between coats of paint. When painting over already painted steel or applying an intermediate top-coat, contaminants remaining on the first coat will interfere with the bonding of the second coat. Achieving intercoat cleanliness usually involves the removal of dust, chalking, oil spots, markings and spills.

Re-cleaning is necessary before any touch-up or re-coating work is done. A coating on a ship may be damaged in a number of ways: burns from welding, chipping from metal tools, or scaffolding and other equipment being dragged across the painted steel surfaces by other craftsmen. This kind of damage to the paint film must be corrected to prevent corrosion attack at the exposed areas.

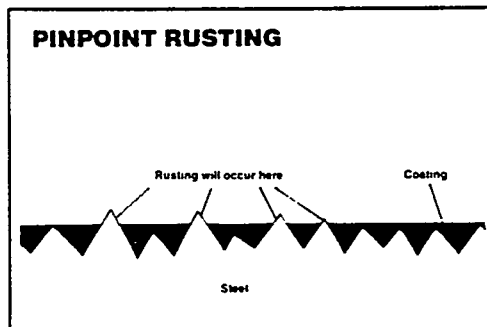
2. ANCHOR PATTERN IMPROVES PAINT BONDING



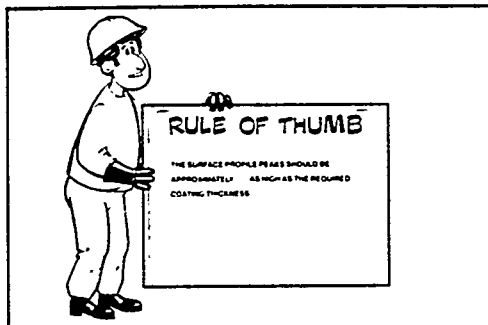
A clean surface is not necessarily a paintable surface. Coatings also require the surface to have "anchor pattern," "profile," or "tooth." This is a rough pattern of peaks and valleys which improves the ability of the paint to bond to the steel by increasing the steel's surface area.



Although new steel looks smooth to the naked eye, in reality the surface is irregular and rough. Paint bonding will be improved by creating a rough but uniform surface. This is achieved by abrasive blasting. The pattern of roughness on the surface affects paint adhesion. If the distance between peaks is too large, the surface will not be rough enough for good adhesion. This pattern is controlled primarily by the shape and hardness of the abrasive used.

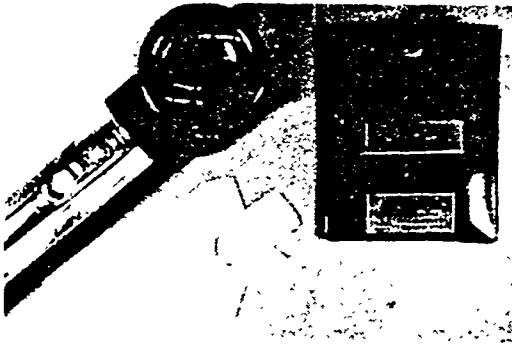


Profile, the height between the peaks and valleys, is measured in mils (.001 inches) and must be carefully controlled for the particular coating system being used. If the peaks are too high, they will stick out above the coating film. These tiny uncoated peaks will lead to pinpoint rusting which can cause more widespread rusting and coating failure. A good coating work procedure will tell you how high the peaks must be for that job.

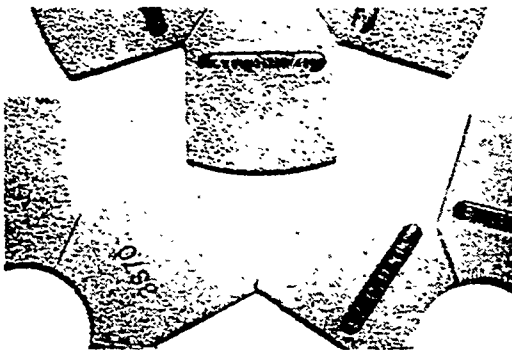


RULE OF THUMB

The surface profile peaks should be approximately 1/3 as high as the required coating thickness.



Profile height is determined by measurement with special instruments. While a good blaster or supervisor who knows his/her equipment and abrasives may be able to estimate the profile height achieved when working at a certain pace, accurate measurement is still necessary. The most commonly used inspection tool is the profile comparator. This consists of a magnifier, light, and discs blasted to different known profiles. The disc and magnifier are placed on the surface and a visual comparison is made.



Discs blasted with sand, grit, or shot are available.

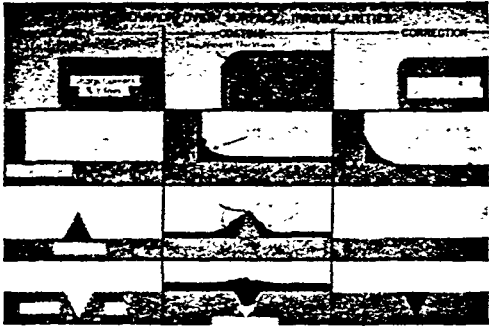
DISCUSSION NOTES

If your supervisors are expected to measure profile, discuss the use of this instrument. Have the comparator, batteries, a variety of discs and a variety of metal panels available. Emphasize the importance of using the shot, sand, and grit discs appropriately. The wrong disc will give the wrong reading. Readings are usually made to the nearest 0.5 mil.

Many yards use the needle gauge. This instrument gives a direct reading of profile on the dial. Emphasize the importance of calibrating the gauge to zero on a glass surface. Caution students not to pull the gauge across the surface. This will blunt the needle. Lift and move the gauge to take multiple readings.

Allow each student to measure one panel with each instrument. Compare and discuss the results.

3. SURFACE CONDITIONS REQUIRING SPECIAL WORK



Cleanliness and anchor pattern are critical for paint adhesion. In addition, there are special surface conditions frequently encountered on ships which must be corrected before the coating may be applied.

Sharp edges will cause paint to draw thin. These should be ground to form smooth, rounded edges. No standard exists at this time for determining how round an edge should be. A 1/8 inch diameter is current practice; however, it is not practical to continuously check edge roundness with a radius gauge. Good judgement must be used in determining that the edges are round enough to prevent the coating from drawing thin.

Inside corners provide a collection point for excess paint. Careful spray technique is required here to prevent thick, cracked, and spongy deposits of paint. Inside **corners** should be welded and ground to form a smooth, rounded inside contour.

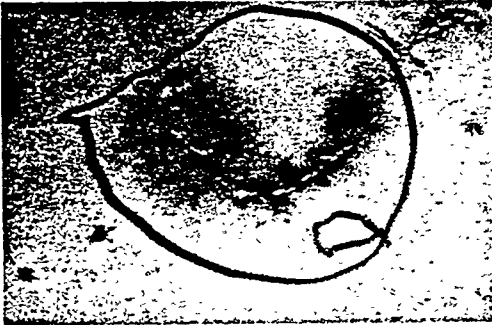
Projections such as raised hackles, metal splinters, and weld splatter should be ground flush. They will protrude through the coating inviting spot rusting.

Crevices and pits should be filled with weld metal and ground flush to the surface.

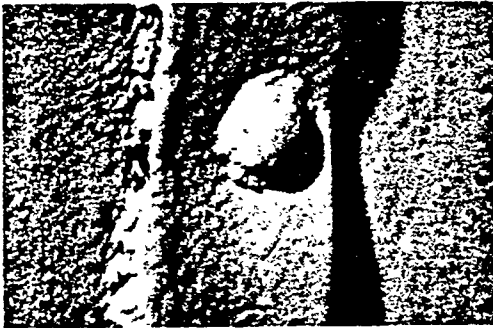
Paint will fail if special attention is not given to these problem conditions.

Edge failure





Rust around weld splatter



Crevice corrosion



Peeling from galvanized surface

Aluminum and galvanized surfaces usually require special chemical pre-treatments and the application of a vinyl wash primer. Wash primers contain phosphoric acid which reacts with the zinc in the galvanizing to form a tight bond. They must be spray applied in a very thin film, $\frac{1}{2}$ mil thick. Usually, they must be topcoated within 24 hours.

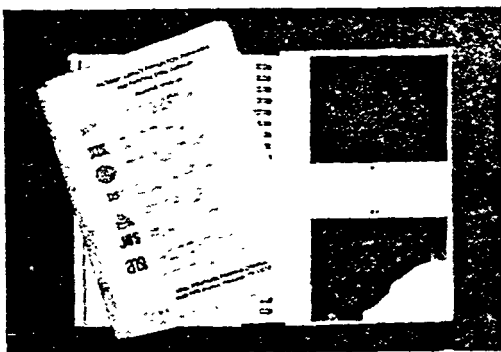
4. SETTING STANDARDS FOR BLAST CLEANED STEEL

Paint performance relies heavily on good surface preparation. It is estimated that 75% of all paint failures are the result of inadequate surface preparation. Poor cleaning prevents the coating from bonding properly to the steel surface. Peeling can result.

On the other hand, overcleaning wastes time and abrasive material; it is unnecessarily costly. Therefore, it is critical that everyone involved with the painting of a ship understand how clean the surface must be for each particular job.

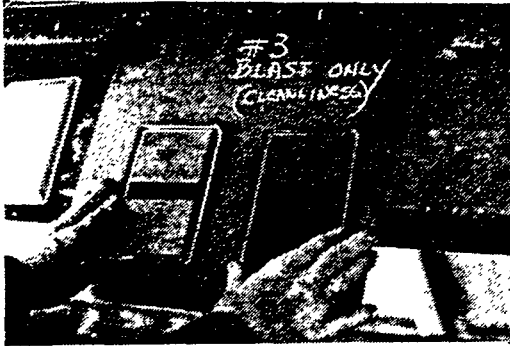
Standards provide written and visual descriptions for judging the acceptability of a blast cleaned surface. They have been developed by national professional societies to help operators, supervisors, owners and inspectors agree on the degree of surface preparation expected and received. Usually they are used to judge the blasting quality in progress. In some yards they are used before the job is begun to establish a sample blast panel or "coupon." Once the blasting department and inspectors agree that the "coupon" is correct, this sample becomes the job standard.

Three different sets of standards are in common use in shipyards: SSPC, NACE, and SNAME.

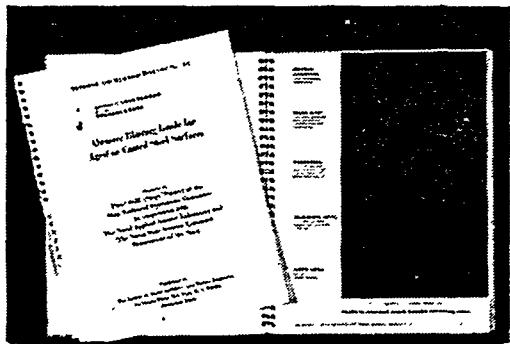


Most marine coating work procedures refer to SSPC standards or Swedish Pictorials. These are widely used throughout the world. They contain written descriptions of four blast grades: brush-off, commercial, near-white, and white metal. Colored photographs show the appearance of the blasted steel surfaces. For each blast grade there are four different sets of photographs. This takes into account the original appearance of the steel surface.

For example, if old pitted and rusted steel is blasted to a near-white surface, it will not have the same appearance as a near-white grade achieved on new steel.

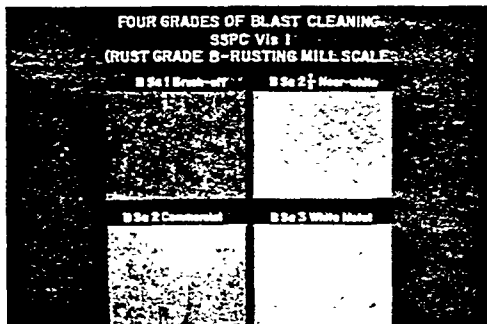


NACE standards rely on the same written descriptions of the four blast grades of steel. Instead of photographs, the NACE standards are small steel plates encased in plastic. Standard plates are available which have been prepared with different types of abrasive materials. This is an advantage of NACE standards since the same blast grade will have a different appearance when sand, steel grit, or steel shot is used. All of the plates are made from new steel. Unlike the SSPC standards, NACE standards do not take into account the original appearance of the steel surface.



The SNAME standard is a pictorial guide. It consists of photographs showing nine different steel conditions which have been cleaned to each of the four blast grades. The steel conditions are typical of those found in ship repair work. To use the SNAME guide select the color photograph which represents the type and original condition of the steel to be blasted. After blasting, hold the photo at arm's length and match the blast grade desired to the blast cleanliness achieved.

5. STANDARD GRADES FOR BLAST CLEANED STEEL



The four standard grades for blast cleaned steel are brush-off, commercial, near-white and white metal blast. The written definitions for these grades are very similar among the different standards organizations. Since SSPC standards are the most widely used in shipyards, the SSPC code number and description is given below.

Communication between the inspector, paint superintendent, supervisors, and operators will be easier if both the name and code number are remembered and used.

The four standard grades for blast cleaned steel are

Brush-Off Blast Cleaning (SSPC-SP7)

All oil, dirt, rust scale, mill scale, loose rust and loose paint are removed completely. Tightly adhering mill scale, rust, and paint are permitted if the blasting has exposed numerous flecks of the underlying metal. These flecks must be uniformly distributed over the entire surface.

Brush-Off Blast, SP7, is a relatively low cost cleaning method. It is often called for in place of power tool cleaning and may be used to lightly clean a modular unit which has been shop-primed before applying topcoats in the field.

Commercial Grade Blast Cleaning (SSPC-SP6)

All oil, dirt, rust scale, rust and mill scale and old paint are completely removed. Slight shadows, streaks, or stains from rust or mill scale oxide, may remain. Slight rust or paint residue may remain in the bottom of pits. At least 66 percent of each square inch of surface is free of all visible residues.

Near-White Blast Cleaning (SSPC-SP10)

Complete removal of all oil, dirt, mill scale, rust, paint or other foreign matter. Very light shadows or slight streaks or discolorations may remain. At least 95 percent of each square inch of surface is free of all visible residues.

A Near-White Blast, SP10, can be achieved at a 10-35 percent lower cost than a white metal blast. Coating life is not affected. This grade, which calls for the removal of 95 percent of all foreign matter, is important for high performance coatings such as coal tar epoxy, zinc rich systems, and vinyl systems.

White Metal Blast Cleaning (SSPC-SP5)

Complete removal of all foreign matter. The steel has a gray-white uniform metallic color and is slightly roughened to form an anchor pattern. (Note: The color of the cleaned surface may be affected by the abrasive used.)

SP5 White Metal Blast is the most expensive and difficult blast grade to achieve since it calls for the removal of 100 percent of foreign matter, including stains, to achieve a "bright white" appearance. Shipyards have found that the large amount of work required to remove the last traces of streaks and shadows is usually not warranted.

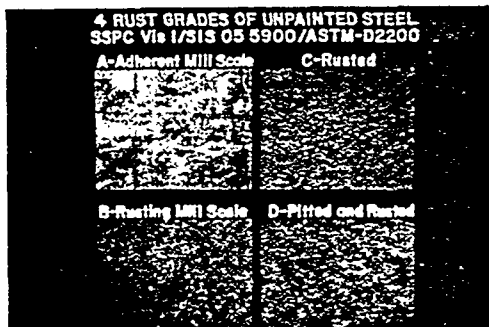
6. USING THE SSPC STANDARDS

The photographs which accompany the SSPC definitions for grades of cleaning make it possible for a blasting job to be visually checked against a recognized standard of quality. To do this properly requires you to check two sections of the book. Part 1 shows pictures of four conditions of new steel before cleaning begins. Part 2 shows pictures of the same original surfaces after blasting to each of the four standard blast cleaned grades.

To use the SSPC Blast Cleaning Standards correctly, follow these steps:

STEP 1. Before blasting begins, determine the original condition, or initial rust grade, of the steel. The four initial rust grades are

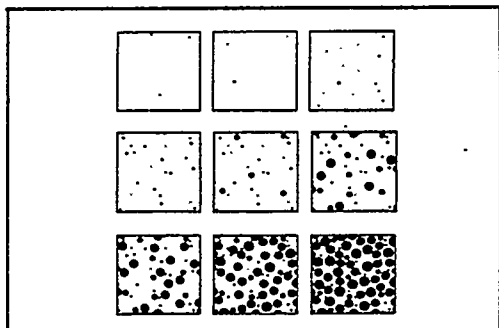
- Rust Grade A - Adherent Mill Scale: surface is covered with tight, adherent mill scale and little, if any, rust.
- Rust Grade B - Rusting Mill Scale: surface has begun to rust; mill scale has begun to flake.
- Rust Grade C - Rusted: mill scale has rusted away or can be scraped from the surface, but with little pitting visible to the naked eye.
- Rust Grade D - Pitted and Rusted: mill scale has rusted away and pitting is visible to the naked eye.



STEP 2. First look at the blasted steel, then identify the photograph which represents the desired cleanliness. Visually compare the correct standard photograph with the newly cleaned surface. Experience and good judgment will develop with practice.

STEP 3. Be certain that the newly blasted surface meets the written description. Observe carefully. Use the photograph as a guide. In every case, the written description defines the standard and is more important than the photograph.

- Do not confuse slight rust stains with actual rusting.
- Certain types of dirt containing iron compounds may discolor the surface. Do not mistake this for corrosion.

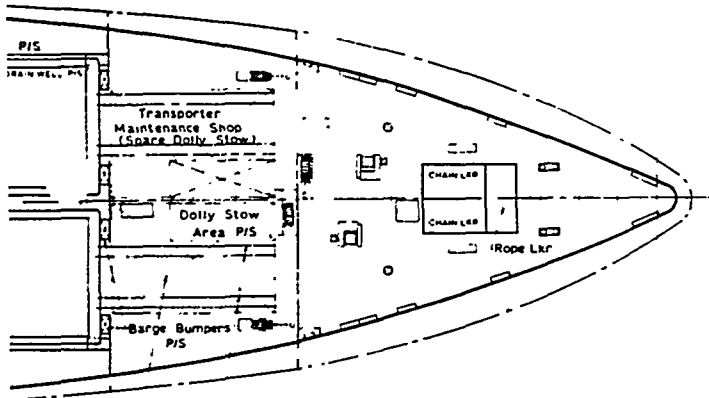


- Pay attention to the "square inch rule." SSPC standards require that the cleanliness requirements be met over each square inch of the surface. For example, a surface which is 95 percent free of all contaminants (except allowable streaking or shadows) may be rejected as meeting SP10 criteria by the inspector, if the allowable 5 percent stain occurs in several large patches.

The "square inch rule" often causes difficulty. Determining the percent of rusted area is a matter of judgment which needs to be developed in supervisors, inspectors, and operators alike. Test your judgment on the following illustrations. Assume the black to be rust. Which square most closely resembles a 5 percent rusted area? -- 33 percent rusted area?

The correct answers are

SQUARE #	1	2	3	4	5	6	7	8	9
PERCENT OF RUSTED AREA	50	33	16	10	3	1	0.3	0.1	0.03%



PART B

QUIZ

UNIT I IMPORTANCE OF SURFACE PREPARATION

NAME: _____

DATE: _____

INSTRUCTOR: _____

GRADE: _____

Circle the most correct answer.

1. Blast cleaning is for removing
 - A. mill scale, rust, and dirt.
 - B. mill scale, rust, and oil.
 - C. all contaminants.
 - D. loose paint and loose rust.
2. Which surface preparation method will NOT remove oil and grease?
 - A. steaming
 - B. solvent wiping
 - C. steam/detergent cleaning
 - D. blasting
3. Paint bonding is improved when the steel surface has a
 - A. bright white and smooth finish.
 - B. 2 mil profile.
 - C. uniform irregular surface.
 - D. low peak to valley ratio.
4. The proper degree of surface cleanliness is
 - A. 95% removal of all foreign matter.
 - B. 66% removal of all foreign matter.
 - C. is determined by the inspector.
 - D. is determined by the paint to be used and the part of the ship to be painted.
5. Surface cleanliness and surface profile
 - A. are two important factors for good paint bonding.
 - B. are almost the same thing.
 - C. are both measured by using SSPC, NACE, or SNAME standards.
 - D. are only important for tank linings.
6. Blasting sometimes raises steel splinters or hackles. These should be
 - A. left alone. They are rough and improve paint bonding.
 - B. steam cleaned to remove salts.
 - C. covered with a wash primer.
 - D. ground flush with a sanding disc or wire brush.

7. Standards for steel surface cleanliness

- A. are tools for the owner's inspector only.
- B. require interpretation and judgment.
- C. clearly show exactly how your surface should look.
- D. are helpful in case of a paint failure.

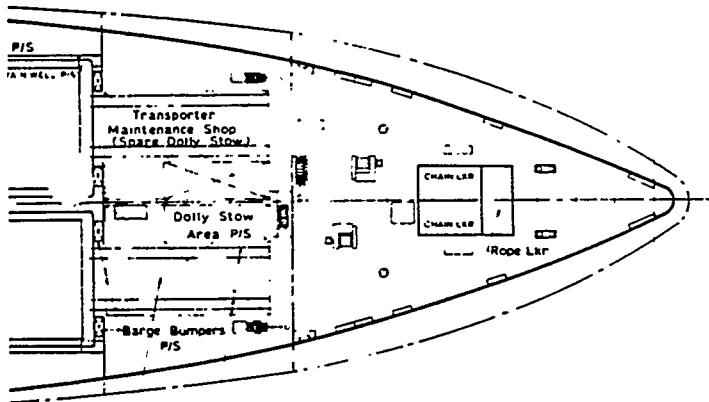
8. You have finished blasting and want to check your work before the inspector arrives.

- A. Compare the photographic standard to your work.
- B. Check the written description; use the photographs as a guide.
- C. Check one square inch. If it is right, the rest will be right.
- D. Do a quick brush-off blast; inspectors are fussy.

Check the correct answer.

TRUE FALSE

- | | | |
|--|-----|-----|
| 9. "Adhesion" and "bonding" are similar terms which refer to a paint's ability to wet and hold onto a surface. | [] | [] |
| 10. "High performance" paints are so named because they perform well over rust. | [] | [] |
| 11. Alkyds penetrate rust to some degree. | [] | [] |
| 12. Topcoating over a coat of cracked or flaking paint will improve the adhesion of the undercoat. | [] | [] |
| 13. Surface cleanliness is less important to intercoat bonding than to substrate bonding. | [] | [] |
| 14. Mill scale develops when cleaned, unprimed steel is exposed to the atmosphere for 8-12 hours. | [] | [] |
| 15. A vinyl wash primer improves paint bonding to a galvanized surface. | [] | [] |
| 16. Overcleaning is costly but worth the effort. | [] | [] |
| 17. A small amount of mill scale is left on the blasted surface. All dirt and rust are removed. This is a good commercial blast. | [] | [] |
| 18. A near-white blast gives good paint performance and is cheaper to obtain than a white metal blast. | [] | [] |



PART B

QUIZ

UNIT II

HOW TO CHOOSE THE PROPER METHOD FOR SURFACE PREPARATION

NAME:

DATE:

INSTRUCTOR:

GRADE:

Circle the most correct answer.

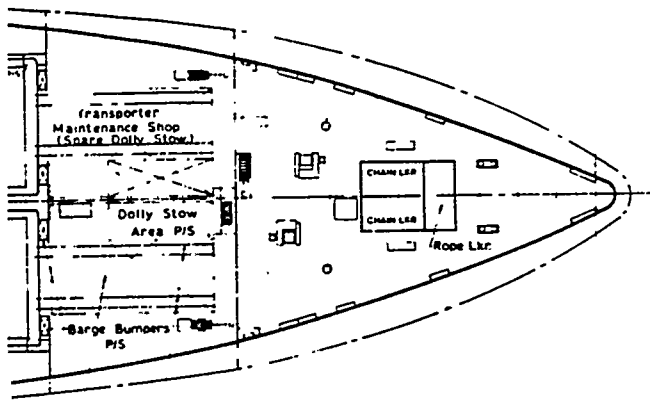
1. Wheel blasting is preferred for
 - A. improved cleanliness over nozzle blasting.
 - B. flats; shapes must be blasted by hand.
 - C. high volume production.
2. Which cleaning methods loosen and remove contamination by impact?
 - A. chisels, needle guns, blasting.
 - B. rotary brushes, hammers, sanders.
 - C. chippers, sanding discs, blasting.
3. Which is not a factor in selecting the proper surface preparation method?
 - A. the original condition of the steel.
 - B. amount of working space.
 - C. the surface area to be cleaned.
 - D. the dew point at the job site.
4. Very thick and loosely adhered contaminants are best removed by
 - A. abrasive blasting, using sand.
 - B. needle chipping.
 - C. solvent washing.
 - D. scraping.
5. Cleaning of post-erection weld seams is commonly achieved by
 - A. blasting to a commercial grade.
 - B. power wire brushing or sanding.
 - C. flaming.
 - D. needle chipping.
6. Which of the following statements about solvent cleaning is false?
 - A. Surface grease may be spread over a large area if rags are not frequently changed.
 - B. Solvent cleaning should follow mechanical cleaning to avoid a greasy residue.
 - C. Danger of explosion increases when solvent-cleaning is performed in a confined area.
 - D. The solvent must be changed between applications as it becomes contaminated.

7. Hand tool cleaning may be the method of choice in all situations except
- A. prior to application of zinc rich coatings.
 - B. touch-up of small areas.
 - C. around rivet heads.
 - D. removing weld splatter.
8. Hand tool cleaning is primarily used in shipyards on surfaces that will receive
- A. zinc rich primers.
 - B. chlorinated rubber.
 - C. bituminous or oil-based paints.
 - D. epoxies.
9. The best method for removing oil, grease, and dirt particles trapped in an oil film is
- A. steam cleaning.
 - B. solvent or chemical washing.
 - C. flame cleaning.
 - D. rotary brushes.
10. Hand tool cleaning is most useful for the removal of
- A. tightly adhered mill scale.
 - B. loose paint, loose rust, dried soil.
 - C. all contaminants.
 - D. mill scale, grease, oil.
11. Deep indentations on the surface caused by scrapers, chippers, and other impact tools
- A. help paint adhere to the surface.
 - B. should be avoided because paint will fail to bond properly.
 - C. give the surface a better profile.
12. Vacu-blast systems are not used to
- A. collect used dust and abrasive.
 - B. touch up weld seams and small rework areas.
 - C. increase surface preparation production.
13. Needle chipping is most suitable for
- A. cleaning large flat areas.
 - B. cleaning small areas which are hard to reach.
 - C. removing oil and grease from deck machinery.

Check the correct answer.

TRUE FALSE

14. Blast cleaning removes all surface contaminants. [] []



PART B

PLANNING NOTES

UNIT II

HOW TO CHOOSE THE PROPER METHOD FOR SURFACE PREPARATION

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Identify the different methods of surface preparation which are available to shipyards, including the capabilities and limitations of each method.
2. Describe the job factors which determine the tools to be used.
3. Explain the following key terms:
 - abrasion
 - abrasive
 - burnish
 - contaminant
 - hydroblasting
 - impact
 - weld flux
 - weld splatter

Equipment/Aids

Slide projector and screen

Samples of actual tools as appropriate for demonstrations and discussion

References

For further information on topics in this unit, you may wish to refer to the following references:

1. SSPC Surface Preparation Specifications
 - SSPC SP-1 Solvent Cleaning
 - 2 Hand Tool Cleaning
 - 3 Power Tool Cleaning
 - 4 Flame Cleaning of New Steel
 - 7 Brush-Off Blast Cleaning
 - 6 Commercial Blast Cleaning
 - 10 Near-White Blast Cleaning
 - 5 White Metal Blast Cleaning

References (continued)

2. Catalogue of Existing Small Tools for Surface Preparation and Support Equipment for Blasters and Painters.
U. S. Department of Commerce Maritime Administration, May 1977.
3. SNAME T & R Bulletin 4-9 "Abrasive Blasting Guide for Aged or Coated Steel Surfaces." 1969
4. SNAME T & R Bulletin 4-11 "Marine Deck Covering Guide."

Discussions/Group Work

Two discussion areas are suggested. If you choose to include these in your lessons, please be certain that the necessary materials and equipment are available.

Topic 1. Chemical pre-treatment of steel. Discuss the technique of cleaning with phosphoric acid-solvents if this or similar practices are common in your yard. Discuss where and why they are used and special safety considerations associated with handling such materials. Stress the safety requirements for handling solvents in confined spaces.

Topic 2. Discuss the surface preparation methods that are used most commonly in your yard. Review the reasons that these methods are used and cover the advantages and disadvantages of each for cost and quality. Prepare a description of a recent job. Include the condition of the substrate, area size and position, paint to be used, scheduling, and other background information. Lead the group in an evaluation of how the six factors described in the text effect the choice of tools for the job.

Unit Quiz

An 18-question quiz is provided with this unit. Duplicate copies for each participant. Allow 10 minutes to complete the quiz. Discuss each question and answer thoroughly.

Answers to Unit Quiz B-II:

- | | | | |
|------|-------|-------|-------|
| 1. C | 6. B | 11. B | 16. T |
| 2. A | 7. A | 12. C | 17. T |
| 3. D | 8. C | 13. B | 18. F |
| 4. D | 9. B | 14. F | |
| 5. B | 10. B | 15. T | |

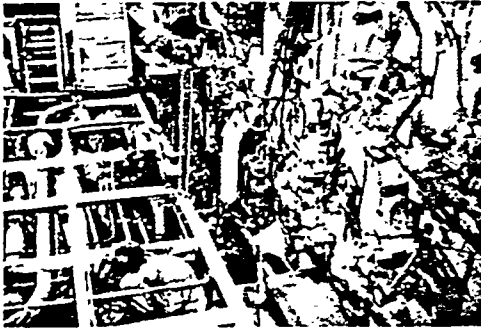
Quiz - Part B, Unit II
Page 3

- | | TRUE | FALSE |
|--|------|-------|
| 15. Waterblasting is used in M & R work to remove marine growth, loose paint, and light rust. | [] | [] |
| 16. Rotary abrading tools may create an unacceptably bright, polished surface. | [] | [] |
| 17. Regardless of the method chosen for removing rust and scale, surface dust and grit must be removed before painting begins. | [] | [] |
| 18. Flame cleaning cannot pop off loose mill scale. | [] | [] |

UNIT II:

HOW TO CHOOSE THE PROPER METHOD FOR SURFACE PREPARATION

1. MANY SURFACE PREPARATION METHODS ARE AVAILABLE TO SHIPYARDS

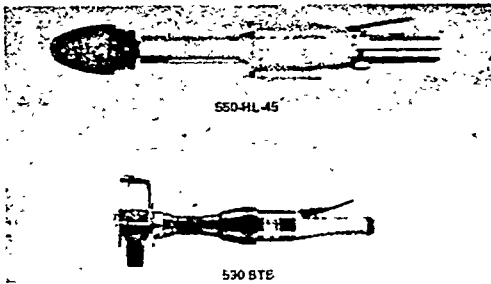


A variety of surface preparation methods are available to shipyards. Each has its advantages and limitations. The choice of method to be used will depend upon the area of the ship to be painted and the type of paint being used. Following are some commonly used methods.

Hand tool cleaning. Hand tool cleaning is most useful for removing loose paint, thick layers of loose rust, dried soil and other loosely adhered foreign matter. It will remove tightly adhered contaminants, foreign matter lodged in pits or crevices, or oil and grease. It is a slow operation, generally chosen for small areas being prepared for touch-up painting or for areas which are inaccessible to larger power driven tools.

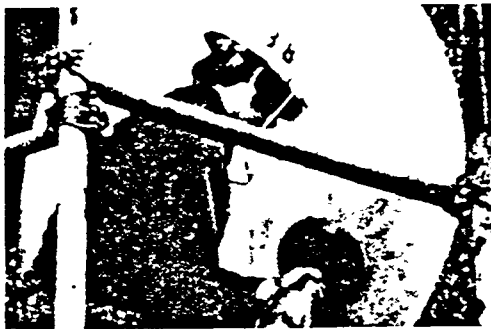
Scrapers, chippers, rust hammers, chisels and knives are commonly used hand tools which remove rust by impact. Care must be taken not to dent the surface metal or to raise burrs which will interfere with paint adhesion. Deep indentations caused by too heavy impact of these tools will leave sharp ridges which must be avoided. Paint will fail quickly over such projections.

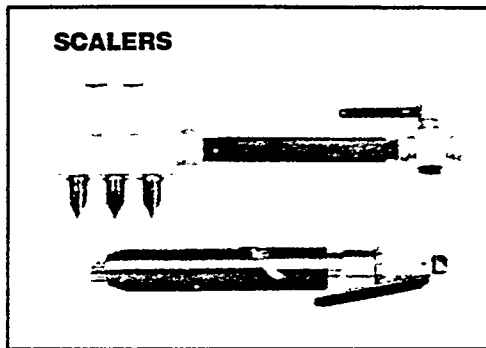
Hand tool cleaning is a limited method. It will not suffice for preparing new steel surfaces for receiving paints which require a very clean surface such as zinc rich primers, epoxy, or chlorinated rubber. In shipyards today, it is primarily used for spot cleaning small areas or for maintenance priming before the application of bituminous coatings and oleoresinous paints used in atmospheric exposures.



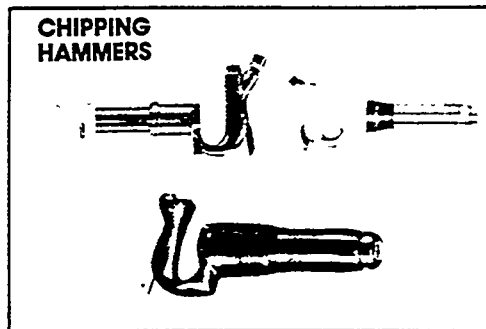
Power tool cleaning. The variety of hand tools available for surface preparation is duplicated in power driven equipment. Wire brushes, sanding discs, grinders, chippers, scalers, needle guns and rotary descenders are available. Power tools achieve a better foundation for paint at a lower cost.

Rotary wire brushes and sanding discs are employed by yards in the preparation of post-erection welded surfaces and heat damaged areas. These power tools are preferred to blasting because there is no grit removal problem and less damage to the coating in adjacent areas. They are also commonly employed for the removal of paint which has been loosened or lifted by rust formation under the paint film.





Needle chipping and similar power assisted impact methods are particularly suitable for small, difficult to get at areas such as bolts, rivet heads, pipe flanges, hatchways, and around deck machinery. These tools are most effective on brittle materials, weld flux, slag and scale. Special care must be taken to avoid making heavy indentations in the metal surface. Air and moisture will collect in these dents, leading to rust formation. Choosing blunt type needles will reduce indentation damage, but production rates will be slower.



Power tools cannot remove all rust and scale. They are generally used for removing loose rust and scale, and for special touch-up work. In recoating work they are often recommended as the minimum acceptable method of surface preparation prior to application of vinyl pitch, bituminous paints, alkyds, vinyl primer, and polyamide epoxy primer.

All power tools tend to polish the surface if used improperly. Avoid too high speed and do not keep a rotary tool on one spot for too long. A burnished surface is a very poor anchor for paint.

In most yards, air powered abrasive tools are replacing electric power tools because they offer greater productivity, less operator fatigue, no overheating problems and low maintenance.

FLAME CLEANING

- 300°F, LOOSENS MILL SCALE, OLD PAINT
- FOLLOW WITH WIRE BRUSHING OR SCRAPING
- WARMS AND DRIES SURFACE
- SLOW: 15-35 LINEAR FEET PER MINUTE
- WEAR GOGGLES, GLOVES, HELMET
- REMOVE ALL SOURCES OF FLAMMABLE GASES

Flame cleaning. In new work, a hot flame is passed quickly over the surface to cause cracking of the mill scale from the metal beneath. Wire brushing follows. Maintenance work requires numerous slow passes of the flame to burn off or soften old paint which may then be scraped. This can be slow, tedious work and the method has been replaced in shipyards largely by power tool cleaning.

SOLVENT WASHING

- REMOVES OIL, GREASE, DUST
- USE CLEAN RAGS
- TURN AND REPLACE OFTEN
- REPLACE SOLVENT FOR FINAL RINSE
- WEAR GOGGLES AND GLOVES

Solvent or chemical washing. Wiping the metal surface with rags soaked in chemicals is a widely used method for removing a variety of oil and grease contaminants and the dust and dirt trapped in the oil film. Since the solvent rapidly becomes contaminated, fresh solvent must be used constantly and the rags turned and replaced. The last wash must be made with clean solvent to avoid a film residue which could interfere with paint bonding.

Chemical washing is an effective way to remove oil but is slow and involves much hand labor. It has no effect on rust or mill scale and is used as a pre-treatment before mechanical cleaning.

DISCUSSION NOTES

Chemical pre-treatments are sometimes required to neutralize certain acids or salts which accelerate rusting when found in even small traces on the steel surface. Phosphoric acid-solvent type metal cleaners are used to inhibit these rust stimulators. The technique is similar to solvent washing.

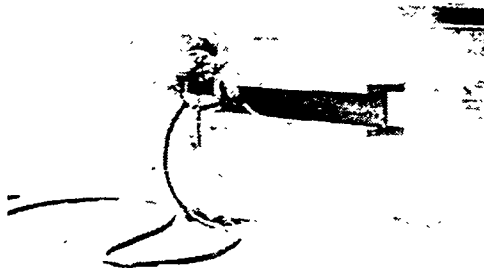
Is the process common in your yard? Where? Why? Are special safety instructions important for handling these materials?



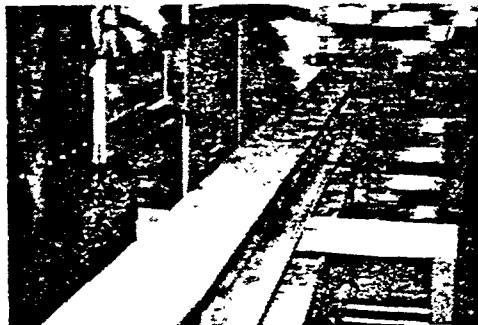
Steam cleaning. Steaming is generally employed to remove dirt and grime on top of existing paint. The high temperature, high velocity wet steam is effective on heavy soil and in areas of the ship where solvent wiping would be difficult. Spot blasting or wire brushing on rusted or abraded areas usually follows. Various commercial detergents are often added to improve the quality of cleaning.



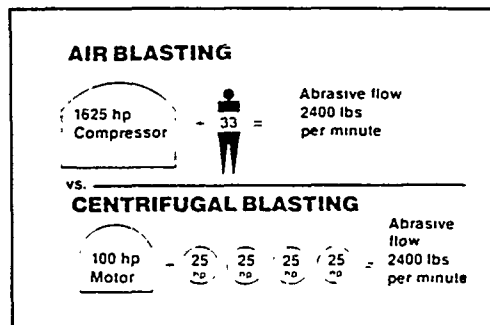
Waterblasting. Waterblasting or "hydroblasting" is more often used in M & R work. When sand is added to the water, loose paint, dirt, and light rust are more easily removed. It is particularly useful for removing marine growth. Shipyards report uneven experience with this cleaning method even at sustained high pressures. Drawbacks include problems of flash rusting and difficult clean-up of the used water and sand mixture.



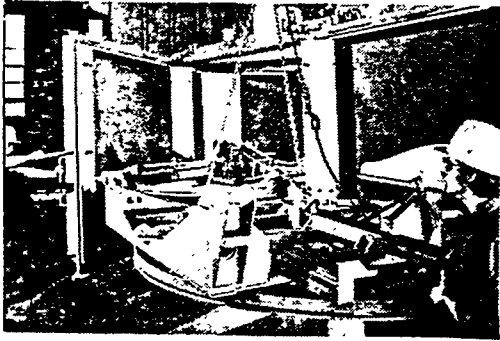
Abrasive blasting. When steel must be totally clean and fully exposed in order to properly receive a coat of paint, blast cleaning is usually recommended. The impact of the high velocity abrasive material completely removes rust, mill scale, and old paint, along with a bit of the base metal. Large flat areas such as the hull are efficiently cleaned by nozzle blasting. Odd shaped pieces may be conveyed through a blast room where blast nozzle direction is controlled by an operator and recirculation of abrasives is possible.



In blast cleaning, lowest costs are achieved when large regularly shaped pieces or plates can be passed through a wheel blast cleaning system at a high rate of speed. Recirculation of abrasives in a blast machine is economical and most machines require only one of two attendants.



A blast cabinet employing four 25 horsepower (hp) wheels would throw 2,400 pounds per minute of steel abrasives. To equal this flow of abrasive using compressed air would require 33 blasters using 3/8" nozzles at 90 psi with a total compressor capacity of approximately 1,650 hp.



Odd shapes may be cleaned in a specially designed blast cabinet in which the wheels are angled to throw abrasives at all surfaces.



Vacu-blast systems which collect the used abrasive and dust are available. Production is slow and they are most frequently used for weld seam touch-ups and small rework areas.

2. SIX FACTORS DETERMINE THE BEST CHOICE

The factor which plays a major role in the selection of a cleaning method is the type and amount of contaminant present. The following chart indicates the commonly chosen cleaning method based on the type of contaminant.

SLIDE OF CHART

CLEANING METHOD	CONTAMINANT	
SOLVENT CLEANING	Grease	Dirt
STEAM CLEANING	Oil	Salt Dirt
WATERBLASTING	Marine Growth	Loose Paint
	Loose Rust	
HAND OR POWER TOOLS	Loose Mill Scale	Weld Flux
	Loose Rust	Weld Splatter
	Loose Paint	
FLAME CLEANING		
FOLLOWED BY	Loose Mill Scale	
WIREBRUSHING	Some Tight Mill Scale	
ABRASIVE	All Visible Rust	Tight Paint
BLASTING	Tight Mill Scale	Foreign Matter

Five factors which affect the tools chosen for the job are

CONSIDERATIONS FOR CHOOSING THE PROPER TOOLS

- 1 Original Condition
- 2 Type of Paint
- 3 Size
- 4 Amount of Working Space
- 5 Legislation

The original condition of the steel. Fabrication, handling, and storage conditions of the steel may give rise to problems of paint failure. Metal projections around edges or punched holes may require buffing or grinding. Welding creates several types of residues which require careful removal: chipping and brushing of weld flux; rotary brushing, grinding or chipping of weld splatter; blasting of chemical deposits. The condition of old steel which may be badly scarred or pitted will also affect the cleaning method chosen.

The type of paint applied, its wetting properties and surface profile requirements.

The size of the surface and structures to be cleaned.

The amount of working space and area set-up, including distance to machinery where grit and dust could ruin working gears and interfere with workers in other crafts.

Legislation on safety, health, and environmental issues which may limit discharge of dust and solvent emissions.

In repair yards, power tool cleaning is used extensively for work in voids, on weld decks, engine rooms and bilges. Even potable water tanks and other tanks located under the engine spaces are hand tool cleaned when the owner's schedule does not permit drydocking and cleaning must be accomplished onboard. Time is often a limiting factor in the choice of method.

DISCUSSION NOTES

What methods are most often used in your yard? Why are they chosen? Discuss the pros and cons of each choice from the standpoint of cost and quality of work.

3. BLASTING IS IDEAL FOR MOST HIGH PERFORMANCE COATINGS

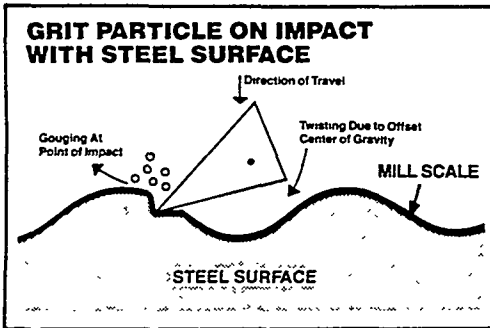
Modern high performance protective coatings demand a high degree of surface cleanliness as well as a controlled roughness, or anchor pattern. Abrasive blasting is the only method of surface preparation which can remove completely intact mill scale and provide the anchor pattern necessary for good paint adhesion.

Blasting is also ideal for:

- high production work;
- rapidly cleaning large areas;
- removing tight mill scale and foreign matter;
- creating a controlled anchor pattern; and
- profitability.

SNAME recommends blasting to commercial or near-white cleanliness for the application of all paint systems in new construction work.

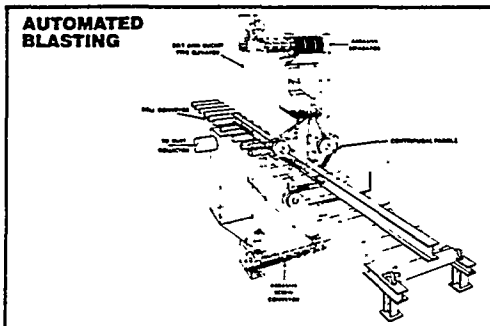
4. HOW BLASTING WORKS TO CLEAN THE SURFACE



Abrasive blasting is the propelling (shooting) of small, hard particles such as shot, grit, or sand, at a surface with great force to loosen and remove dirt, rust, mill scale or other contaminants and to create a good profile before applying paint.

Nozzle blasting is used on exterior hulls, deck houses, and decks. It is used to repair burned and damaged areas in tanks and ship exteriors. In repair yards, nozzle blasting is the major method of surface preparation.

The force behind nozzle blasting is compressed air. The volume and pressure of the air must be controlled for efficient work. The abrasive material leaves the nozzle at a speed of 200 to 400 miles per hour. The force with which it hits the surface breaks and loosens the layer of contamination. The pieces of rust, mill scale, dirt, etc. fall to the ground with the used abrasive.



Shipbuilding technology today relies on an automated system of abrasive blasting and spraying. Sheets (flats) and structurals (shapes) are blasted in some form of automated blasting unit. Here the power which shoots the abrasive at the metal surface does not come from a compressed air source. Rather the abrasive is thrown at the steel by a wheel or rotating set of paddles. The cleaning principle remains the same as nozzle blasting.

5. BLASTING HAS LIMITATIONS

BLASTING DON'TS



There are some conditions in which blasting IS NOT the most efficient method for surface preparation:

- removal of oil and grease
- removal of loose, very thick layers of rust and paint
- when the service requirements allow a more forgiving type paint and such a degree of cleanliness is not required.

Oil and grease. Blasting is not effective for removing oil and grease. The impact of the abrasive just moves the oil around. If a closed system is used and the abrasive is recycled, oil becomes an even bigger problem. The abrasive becomes covered with oil in the first use and on re-use leaves oil traces on the clean steel.

Loose, very thick layers of rust and paint. Loosely adhering rust is NOT efficiently removed by blasting. Blasting is slow and a great deal of abrasive is needed to do the job. Hand scraping should proceed blasting to remove loose paint and other loose, thick materials.

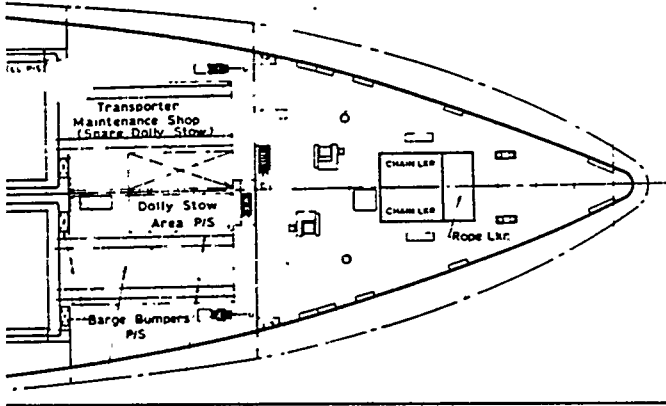
Milder service requirements. Certain areas of the ship do not call for paints requiring exhausting surface preparation. The upper and lower engine rooms, shaft alley, steering room and other interior spaces are sometimes painted with alkyds and oil-based primers which will bond reasonably well to a surface which is power tool cleaned. Abrasive blasting may not be cost effective for such applications.

In spite of the overall efficiency and good results of blasting, some problems still occur, such as:

- Damage to sound coatings as a result of abrasive ricochet while repairing adjacent defects or weld areas.
- accumulation of used abrasives in tanks, bilges, etc. can be difficult to remove;
- blowing dust and abrasive in the air can damage machinery and interfere with the work of nearby craftworkers;

- air borne dust can be harmful to the operator; a respirator must be worn while operating blast equipment; and
- abrasives are costly; recycling should be considered wherever possible.

These problems can be reduced with correct use of the equipment and proper planning and scheduling.



PART B

PLANNING

NOTES

UNIT III

EQUIPMENT SET-UP FOR

NOZZLE BLASTING EFFICIENCY

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Identify the five basic parts of an open blasting rig and describe the purpose of each part.
2. Explain the relationship of nozzle pressure and nozzle size to cleaning efficiency.
3. Review the importance of air pressure and air volume.
4. List at least 10 ways to maximize blasting efficiency.
5. Explain the following key terms:

- CFM	- peen
- friction	- psi
- interior diameter (ID)	- venturi nozzle

Equipment/Aids

Slide projector and screen

Abrasive samples (natural, metallic, slag, synthetic)

Optional: Steel plates, blasted with different abrasives
 Cross sectioned blast hose
 Hose ends with external couplings
 Portable blast pot

Discussions/Group Work

Topics 1-6. A movie, "Blast Off," is available which summarizes many of the points made here. It is available from: Clemco Industries, 2177 Jerrold Avenue, San Francisco, California 94124, ATTENTION: Marketing Services. Write to book the movie well in advance. It will be sent at no charge.

Topic 7. Types of abrasives. Discuss the types used in your yard for various jobs. Pass around samples to show how they look and feel. Make up steel plates blasted to the same profile depth and cleanliness for each abrasive shown.

Unit Quiz

A 15-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

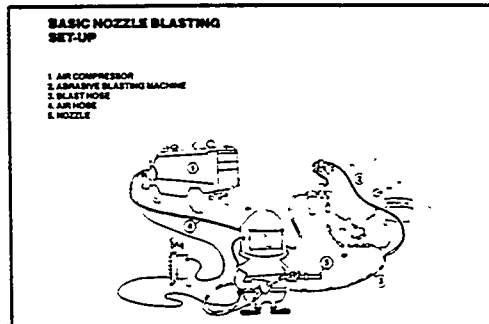
Answers to Unit Quiz B-III:

- | | | | |
|------|-------|-------|-------|
| 1. B | 6. D | 11. F | 16. T |
| 2. C | 7. A | 12. T | 17. T |
| 3. A | 8. D | 13. T | 18. F |
| 4. D | 9. B | 14. F | 19. F |
| 5. C | 10. D | 15. F | 20. F |

UNIT III:

EQUIPMENT SET-UP FOR NOZZLE BLASTING EFFICIENCY

1. BASIC NOZZLE BLASTING SET-UP



An open or "nozzle" blasting rig has five basic parts:

1. the air compressor
2. the blasting machine
3. the blast hose
4. the air hose
5. the nozzle

The air compressor provides the high pressure and volume of air needed to propel the abrasives through the nozzle onto the surface.

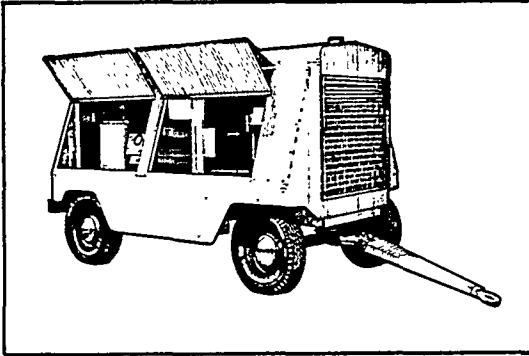
The blasting machine or "sand pot" is a container which holds the abrasives. A valve at the bottom measures and controls the amount of abrasive material fed into the blast hose. This may be called a "metering valve."

The blast hose which carries the air and abrasive mix from the pot to the nozzle must be sturdy and flexible. It is treated to prevent electrical shock. Hose is sold in short sections which can easily be joined together to get the required length.

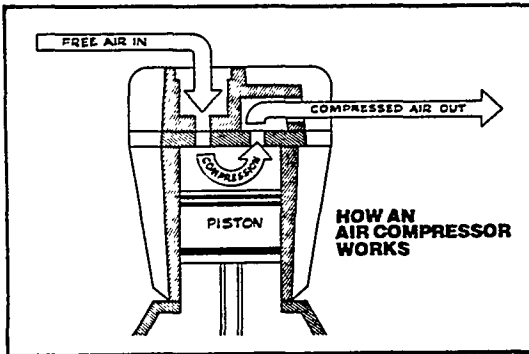
The air hose connects the compressor and the blast pot. This hose is not as rugged as the blast hose, because it is not dragged on the ground and it does not carry abrasive materials which wear down the inner lining.

Nozzles come in various shapes and sizes. Shipyard use recommends the venturi design and as long a nozzle (up to 8") as is practical for the work area. A control valve mounted on the nozzle allows the operator to start and stop blasting without having to return to the pot. Called the "deadman valve" this is also a safety feature. As long as the operator depresses the valve, the blasting pot releases air and abrasives. If the operator should drop the nozzle, the flow shuts off immediately.

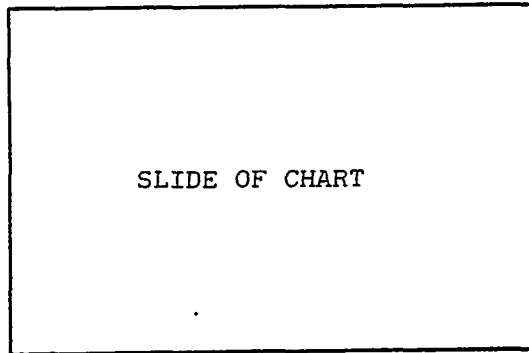
2. THE AIR COMPRESSOR: THE POWER SOURCE



The air compressor is the source of power for any blasting job. The constant supply of a high volume and high pressure air stream hour after hour is the most critical part of the blasting operation.



The compressor works by sucking in large volumes of free air which are filtered and compressed by rotary or piston action and are then released with great force into the blasting machine. The capacity of a compressor -- its ability to suck in, compress, and expel large quantities of air at high pressure -- is measured in cfm units, cubic feet per minute. This capacity is directly related to the compressor's horsepower rating.



COMPRESSOR HP RATING

COMPRESSOR CAPACITY, CFM (Electric Drive)

15	50-70
20	70-90
25	90-105
30	up to 130
40	up to 170
50	up to 210
60	up to 260
75	up to 320
100	up to 420

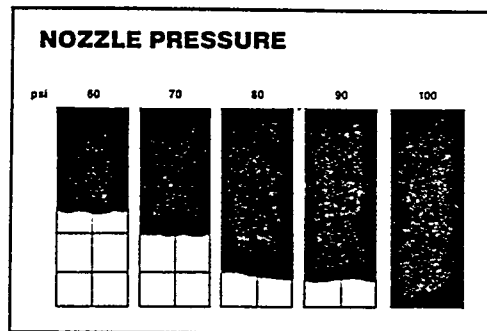
The air demand for blasting is enormous. Cleaning a typical steel plate would require a compressor to move 170-220 cfm of air at a force of 90-100 psi, pounds per square inch, at the nozzle. A 50 or 60 HP compressor would be needed.

Wear on the parts will cause a drop in compression volume. Proper maintenance is essential to maintain constant output.

Efficient blasting also means that the required volume and pressure of air is delivered to the surface free of oil and moisture. Oil and water traps on the machine filter the air. These must be watched, cleaned, and adjusted frequently.

3. AIR PRESSURE AND AIR VOLUME CONTROL EFFICIENCY

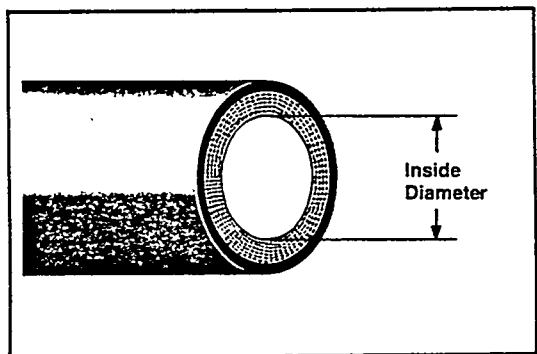
Work is done in direct proportion to both the air pressure and air volume at the nozzle. The larger the compressor, the larger the nozzle it can operate. The larger the nozzle (at the proper pressure) the faster the job can be completed. Blasting on steel plate at 90-100 psi and an air volume of 170-220 CFM is usually done with a 3/8" nozzle.



The importance of nozzle pressure is illustrated here. These panels were blasted with the same equipment, for the same amount of time. Proper nozzle pressure, 90-100 psi, resulted in a 50 percent increase in cleaning efficiency over work done at 60 psi.

Nozzle Pressure	Cleaning Efficiency
100 psi	100%
90 psi	82% approx.
80 psi	78% approx.
70 psi	60%
60 psi	50%

4. CHOOSING HOSE TO REDUCE FRICTION LOSS



For the most efficient blasting job, the air hose which connects the compressor and the blast pot should be as large as possible. Hose size refers to the interior diameter, ID, of a hose and is measured in inches. Because the movement of a large volume of air confined in a narrow hose creates friction, undersized hose results in loss of air pressure and low production blasting. A loss of one pound in pressure means a reduction in production of $1\frac{1}{2}\%$. A ten pound loss can mean a 15% production loss.

Generally, a 1 inch ID air hose is used when the hose is under 50 feet in length. In high production shipyard work, $1\frac{1}{2}$ inch ID hose is common.

Pressure loss due to friction is also a problem when the air must travel through a long length of hose. The compressor should be placed as close to the blast pot as practical. A short air hose minimizes friction losses.

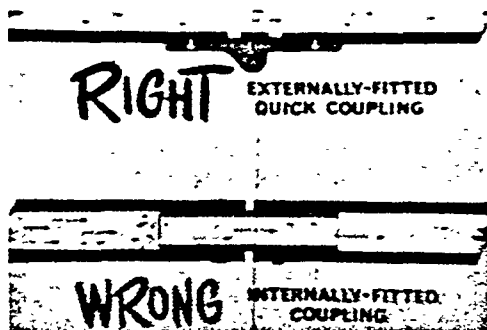
SLIDE OF CHART

PRESSURE LOSS IN AIR HOSE DUE TO FRICTION

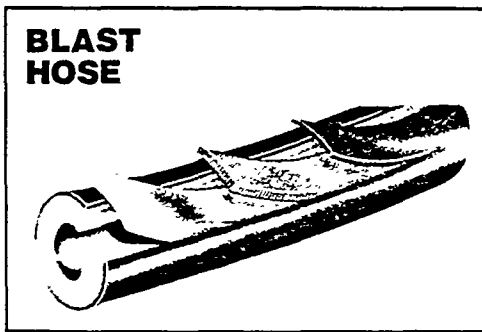
HOSE SIZE, COUPLED END	LINE PRESSURE PSI	CFM FREE AIR PASSING THROUGH 50 FT. LENGTHS					
		40	60	80	100	120	150

		LOSS OF PRESSURE PSI *						
3/4 "	60	1.2	2.8	5.2	8.6			
	80	0.8	1.9	3.6	5.8	8.8		
	100	0.6	1.4	2.7	4.4	6.6	11.1	
	110	0.5	1.3	2.4	3.9	5.9	9.9	
1 inch	60	-	0.6	1.2	2.0	3.3	7.2	
	80	-	0.5	0.8	1.4	2.0	3.5	
	100	-	0.4	0.6	1.0	1.5	2.4	
	110	-	0.3	0.6	0.9	1.3	2.1	
1-1/4"	60	-	0.2	0.3	0.6	1.0		
	80	-	0.1	0.2	0.4	0.6	1.0	
	100	-	-	0.2	0.3	0.4	0.7	
	110	-	-	0.2	0.3	0.4	0.6	

* Pressure drops for other lengths in direct proportion to change in length.



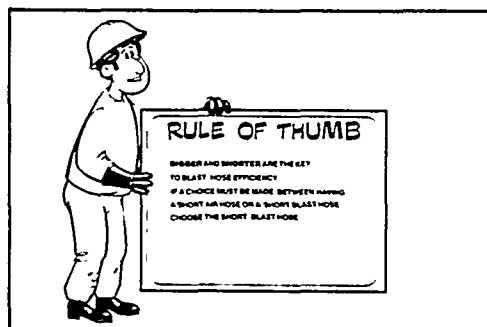
If hose length must be extended by coupling sections of hose together, exterior couplings are preferred. Interior couplings decrease the ID of the hose and create pressure drops. The danger of leakage from the hose is reduced by having as few couplings as possible.



The blast hose connects the blast pot and nozzle. It carries both air and abrasive. Sturdy 4-ply hose with $1\frac{1}{2}$ inch ID is called for in shipyard work. As with air hose, efficiency in blasting will be increased dramatically if a large ID and short length blast hose is used.

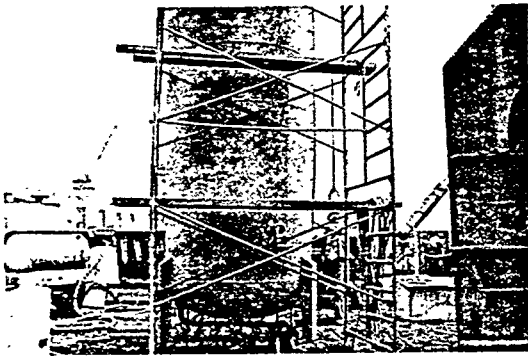
A short length of lighter, more flexible, 2-ply hose with a $\frac{3}{4}$ inch ID is sometimes joined in at the nozzle. These sections, called "whips," are easy to handle. They are effective for work in areas with many angles, pipes, and stiffeners.

Whenever possible, however, whips should be avoided in shipyard work. They add length and the small ID reduces pressure. Whips cancel the advantages gained by the large size blast hose.



RULE OF THUMB

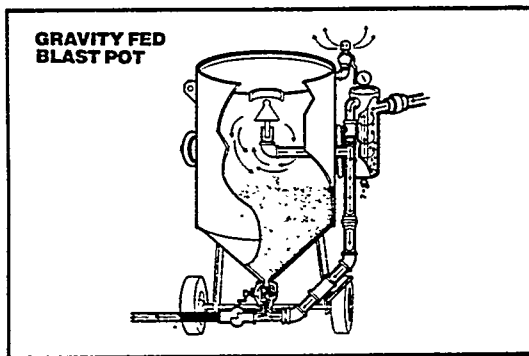
Bigger and shorter are the key to blast hose efficiency. If a choice must be made between having a short air hose or a short blast hose, choose the short blast hose.



Many sizes of blast machine are available, holding from 50 pounds to several tons of abrasive material. The size of the machine depends upon the nature and size of the job. In shipyard work, 40 ton blast pots are frequently used.

Smaller machines require more frequent refill stops which interfere with production. For example, it generally requires 30-40 minutes to use 500 to 600 pounds of abrasive and from 5 to 10 minutes to refill this size hopper. For every 50 minutes worked, 10 are spent waiting for the pot tender to fill the machine -- a 20% loss in production time. A double hopper set-up can provide for continuous, uninterrupted blasting.

In addition to pot size and refill time, efficient blasting depends upon the pot's ability to release an even flow of abrasive with the air stream. Proper abrasive flow is controlled by the meter valve. Some pots have an automatic metering valve which adjusts the flow rate as air pressure fluctuates.



DISCUSSION NOTES

A cut-away view of a typical gravity fed blasting machine is provided. Point out the essential features, including

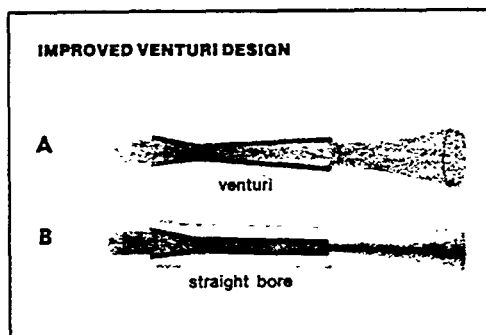
- 1. air hose*
- 2. moisture separator*
- 3. exhaust valve*
- 4. filling head*
- 5. metering valve*
- 6. hose/tank coupling*

6. NOZZLE SIZE AFFECTS WORK EFFICIENCY

Surface cleaning is done in direct proportion to the volume of air pushed through the nozzle at high pressure. The nozzle is not merely an extension of the hose. It is a major working tool in the blasting operation. It is designed in different sizes and shapes for different applications.

Nozzles come in an assortment of lengths, sizes of opening, and lining materials. Because of the heavy demands of shipyard work, it is recommended that nozzles have the following characteristics:

- venturi design
- long nozzle length
- Tungsten Carbide or Norbide lining
- large orifice size



Venturi design. The tapered shape of the lining of a venturi nozzle is significantly more effective than the cylindrical nozzle for concentrating the stream of abrasive material. It has the advantage of increasing abrasive speed to 450 miles per hour and creating a larger, more even blast pattern. Production cleaning rates can be increased by as much as 30-50 percent by this feature.



Long nozzle length. Hard to clean surfaces require as large a nozzle as practical for the work area. Long nozzles, from 5 to 8 inches, will more easily remove tightly adhered deposits and mill scale. They also produce faster cleaning rates. Shorter nozzles, 3 inches or less, may have to be used behind beams or in other small or inaccessible areas.

WORN NOZZLE LINING REDUCES EFFICIENCY



Cast Iron
Tungsten Carbide
Norbide

6-8 hrs.
300 hrs.
750-1000 hrs.

Tungsten Carbide or Norbide lining. As the abrasive material flows past the nozzle opening, the lining wears away. The size of the opening, called the orifice, enlarges and cleaning effectiveness is reduced. Nozzle liners should be replaced when wear increases the opening 50 percent over its original diameter size. Tungsten Carbide and Norbide liners, when properly handled, have a service life of 300 hours and 750-1000 hours respectively. Proper handling of nozzles includes taking care not to drop or bang them against any surface, since they are made of brittle material. While these liners may be expensive, their cost per hour of service is less than that of cheaper models.

NOTE: Tungsten Carbide nozzles may be used with all of the common abrasives except aluminum oxide or silicon carbide. Norbide liners may be used with all abrasives.

NOZZLES

SELECT NOZZLE SIZE
FOR HIGH PRODUCTION



1/4 INCH

3/16 INCH

3/8 INCH

5 MINUTES

Large orifice size. The available volume of air determines the orifice size. Choose the largest possible size that can be used on that job. Generally, a $\frac{1}{2}$ inch nozzle will clean four times as much area in one hour than a $\frac{1}{4}$ inch nozzle, with the proper air supply.

NOZZLE SIZE

WORK EFFICIENCY

1/4 inch	100 square feet
3/16 inch	157 square feet
3/8 inch	220 square feet
7/16 inch	320 square feet
1/2 inch	400 square feet

• SLIDE OF CHART

Choosing the right nozzle is important in maintaining production schedules and labor costs. A nozzle can be too large for the air flow. Air will escape and both pressure and production will drop.

Nozzle Size as a Function of Volume of Air Flow and Air Pressure

Nozzle Size (inches)	Nozzle Pressure	
	90 psi	100 psi
1/8	18.5 cfm	20.3 cfm
3/16	41.0 cfm	45.0 cfm
1/4	74.0 cfm	81.0 cfm
5/16	126.0 cfm	137.0 cfm
3/8	173.0 cfm	196.0 cfm
7/16	240.0 cfm	254.0 cfm
1/2	309.0 cfm	338.0 cfm

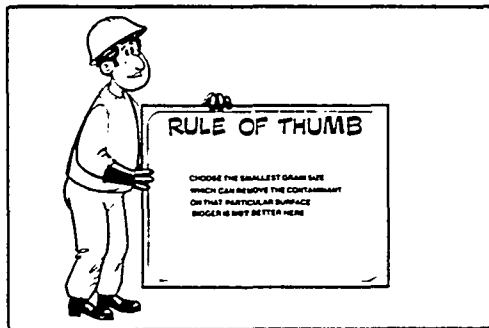
7. FOUR CHARACTERISTICS DETERMINE ABRASIVE CLEANING RATE

The proper abrasive is the one which gives the needed profile for the job and the greatest efficiency. The following characteristics of abrasives control profile and efficiency:

- size,
- hardness,
- breakdown characteristics, and
- shape.

Size. A large or coarse size abrasive grain will cut deeper than a small or fine grain. However, a large grain does not give the same cleaning speed. It is best to use as small a size as possible for greater coverage. If you use an abrasive which is too small for the job, you will give good speed but the cutting power will be lost.

Abrasive particles larger than 16-18 mesh will gouge the surface and have a slow cleaning rate. Fine particles, 100 mesh size or finer, can achieve the usual $1\frac{1}{2}$ to $2\frac{1}{2}$ mil required profile. Particles in the 40-50 range are commonly used in shipyards today.



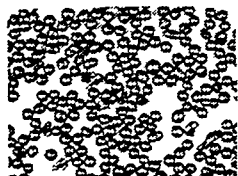
RULE OF THUMB

Choose the smallest grain size which can remove the contaminant on that particular surface. Bigger is not better here.

Hardness. Abrasive hardness also affects cleaning speed. Harder abrasives generally cut faster and faster than soft or brittle abrasives. A hard but brittle abrasive will shatter on impact, reducing its cleaning power.

Breakdown characteristics. Abrasive grains striking the work surface at high speeds are themselves damaged. The way in which these grains fracture (break) and change their shape and size is called the breakdown characteristic. In the field (open or nozzle blasting) this may not be of great importance. In closed cycle blasting it is very significant. Breakdown characteristics determine the number of times an abrasive can be re-used and how often the operator must adjust the mix of new and re-used material. To be effective, an abrasive should be both hard and have a breakdown rate of 10% or less. A greater rate of breakdown causes a great deal of dusting which is a hazard to the blaster, requires extra cleaning of the surface, and increases cost by limiting the number of times the abrasive can be re-used.

ABRASIVE SHAPE



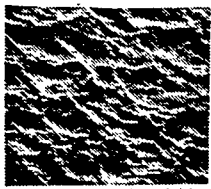
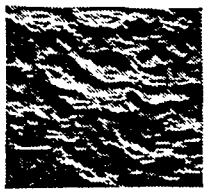
2 grade Shot Steel Grit



Typical New Steel Grit

Shape. The shape of the abrasive grains determines the type of anchor pattern. Shot is round and gives a wavy anchor pattern. It peens the surface. Shot is particularly effective on brittle deposits such as mill scale.

Grit is angular and provides a jagged finish which is preferred for paint adhesion. Sand and slag which are semi-angular give a pattern somewhere between shot and grit.



The four types of abrasive materials used commonly in shipyard blasting are

- natural,
- metallic,
- slag, and
- synthetic.

Natural abrasives. Silica sand and Starblast. Silica sand has been widely used because it is readily available, low in cost, and effective. However, the hazards of silicosis and OSHA and EPA regulations have restricted its use in many areas. Another natural abrasive, Starblast, has received attention. It is efficient, quick cutting, has less dusting, a lower breakdown rate, and may be recycled.

Metallic abrasives. Steel shot and grit. Metallic abrasives are efficient, hard, and dust free. While their initial cost is high, they may be recycled several times, making them cost effective. Shot and grit may be mixed to take advantage of the cleaning properties associated with their different shapes. Care must be taken in storage to prevent rusting.

Slag abrasives. Copper slag and nickel slag. Slags are a by-product of the ore smelting industry. They are fast cutting but have a high breakdown rate and are not recyclable.

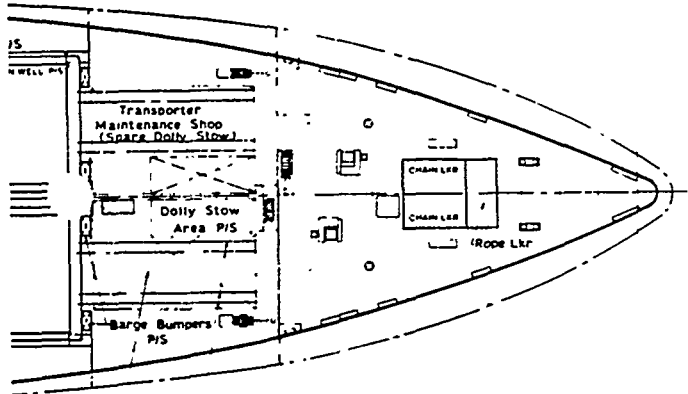
Synthetic abrasives. Aluminum oxide and silicon carbide. These non-metallic abrasives have cleaning properties similar to the metallics with the advantage of being non-rusting. They are very hard, fast cutting, and low dusting. They are costly and should be recycled.

-
- Place the compressor near the blast job as near as possible to the blast pot. Position it so that wind will blow blasting dust away from the compressor, assuring clean air intake.
 - Care for the equipment. Allow the compressor to warm up for 10-15 minutes before starting to blast. Set it at 120 pounds. DO NOT exceed 125. DO NOT overload.
 - Keep the compressor clean. Fans, radiators, and filters should not be clogged with dirt or they will overheat and overload.
 - Drain all water and oil, using the separators on the compressor. Water is produced by the air intake and oil from the action of the pistons.
 - Check the compressor output every 6 months. Is the gauge reading correct? An "orifice gauge" is available for this purpose.
 - Run large air hose from the compressor to the blast pot. Large hose reduces friction in the line.
 - Use external couplings when attaching hoses.
 - Keep hoses as short as possible to minimize pressure loss.
 - Make $1\frac{1}{2}$ inch ID air hose standard practice. Use a $\frac{3}{4}$ inch ID whip only in areas with many angles or stiffeners where greater flexibility is a must.
 - Avoid small blast hose.

RULE OF THUMB

The ID (interior diameter) of the blast hose should be three to four times the orifice size of the nozzle.

- Run hose in a straight line. Avoid 90 degree bends. If hose must curve around an object, use a long curve. Consider safety as well as productivity. Sharp curves create rapid wear and could cause a blow-out.
- Check for nozzle or orifice wear.
- Check mesh size of abrasives which are recycled.



PART B

QUIZ

UNIT III EQUIPMENT SET-UP FOR NOZZLE BLASTING EFFICIENCY

NAME: _____

DATE: _____

INSTRUCTOR: _____

GRADE: _____

Circle the most correct answer.

1. The remote control, "deadman", valve on the blast nozzle
 - A. can stop the flow of abrasives but NOT of air.
 - B. is an important safety device which gives the blaster control of his equipment.
 - C. should be tied or wedged in the "on" position to reduce blaster fatigue and increase production.
 - D. is a nuisance factor created by OSHA.
2. Shipyard production blasting requires
 - A. the largest commercially available compressor.
 - B. a minimum of 90 psi compressor output.
 - C. 90-100 psi of pressure at the nozzle.
3. Using the same air volume and nozzle size, a nozzle pressure of 60 psi compared to a pressure of 90 psi
 - A. will have a 50% lower cleaning rate.
 - B. will save money by using less abrasive.
 - C. will clean at 80% the speed with less abrasive.
 - D. won't remove mill scale.
4. Reduced blasting efficiency due to friction in hose lines
 - A. is of concern in air hose but not blast hose.
 - B. is decreased by using a whip.
 - C. is only a problem if the compressor is undersized.
 - D. can be minimized by using short lengths of wide hose.
5. A loss of ten pounds of blasting pressure can mean a production loss of
 - A. 1%
 - B. 5%
 - C. 15%
 - D. 25%

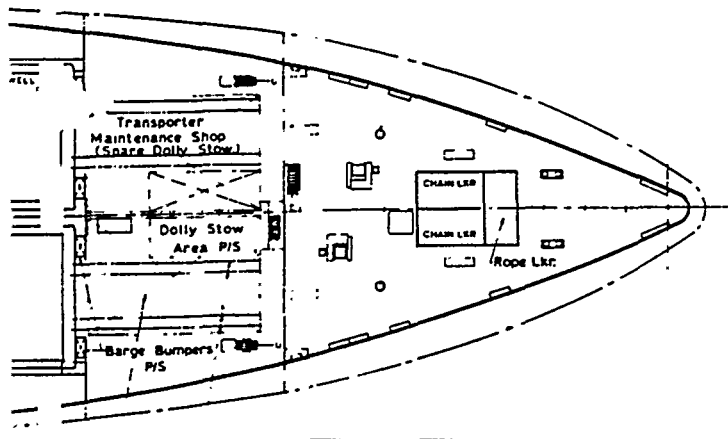
6. Which statement about blast whips is false?
- A. Whips cancel the advantages gained by using a large diameter blast hose.
 - B. Whips should be avoided when possible.
 - C. Being lighter and more flexible, whips may be needed for blasting angles, pipes, and inaccessible areas.
 - D. Being lighter and more flexible, whips reduce worker fatigue and should be used to increase production.
7. The flow of abrasive in the air stream
- A. should be steady to achieve a good cleaning rate.
 - B. should be intermittent or "pulsed" to remove tightly bonded material.
 - C. does not seriously affect cleaning ability.
 - D. cannot be adjusted if the air flow fluctuates.
8. Severe injury can result from pointing the blast nozzle at another person or part of the blaster's own body because the abrasive is shot out of the nozzle at a speed of
- A. 50 mph
 - B. 100 mph
 - C. 200 mph
 - D. 450 mph
9. Blasting efficiency drops as the nozzle liner wears. The liner should be replaced when the orifice size has increased _____ percent of its original size.
- A. 30%
 - B. 50%
 - C. 60%
 - D. 80%
10. Because they are so hard and durable, tungsten carbide nozzle liners
- A. have a service life of 750 hours.
 - B. have a high initial cost but are less expensive in the long run.
 - C. can be dropped or banged without damage.
 - D. A & B

Check the correct answer.

- | | TRUE | FALSE |
|--|------|-------|
| 11. If the pressure gage on a compressor feeding only one hose line reads 100 psi, blasting pressure will be adequate. | [] | [] |
| 12. The blast pot regulates the mix of air and abrasive. | [] | [] |

Quiz - Part B, Unit III
Page 3

	TRUE	FALSE
13. Exterior hose couplings do not reduce the ID of a hose line.	[]	[]
14. The flow of abrasive is controlled by a metering valve on the compressor.	[]	[]
15. Production rate is not affected by pot refill time since the blaster needs a rest anyway.	[]	[]
16. Generally, a $\frac{1}{2}$ " nozzle will clean 400 square feet in the same time that a $\frac{1}{4}$ " nozzle cleans 100 square feet.	[]	[]
17. A long nozzle is more effective for removing mill scale than a short nozzle.	[]	[]
18. The choice of nozzle size depends on the air pressure (psi), not the air volume (cfm).	[]	[]
19. An abrasive with a high breakdown characteristic is profitably reclaimed and recycled.	[]	[]
20. The size of the abrasive has no bearing on the surface profile.	[]	[]



PART B

PLANNING NOTES

UNIT IV EFFICIENT AND SAFE PRACTICES FOR SURFACE PREPARATION

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Explain how nozzle angle and distance to surface are related to an effective blasting operation.
2. Demonstrate the use of a hypodermic needle gage.
3. Identify the most common health hazards facing the blasters and other surface preparation operators and discuss prevention measures.
4. Discuss how accidents can occur during surface preparation operations and review ways to avoid them.
5. Explain the following key terms:
 - bronchitis
 - deadman valve
 - dermatitis
 - grounding
 - respirators: cartridge, filter, air-fed
 - silicosis
 - toxic

Notes to the Instructor

1. This unit focuses on EFFICIENCY and SAFETY in blasting. The unit may be taught at two different sessions, one in the classroom and one in the field. Have all of the equipment listed below available in the classroom for demonstration. Then, duplicate this set-up in the field allowing for hands-on practice in an actual work situation.

2. SAFETY PROGRAMS. The International Brotherhood of Painters and Allied Trades (IBPAT), under contract to OSHA, has produced an Occupational Safety and Health Training Project. These videotape programs include general programs in unsafe and unhealthy working conditions, selected respirator programs, and spot messages on topics such as solvent intoxication. A project catalog is available from: IBPAT, Occupational Safety and Health Training Project, United Unions Building, 1750 New York Avenue, N.W., Washington, D.C. 20006; Tel. 202/872-1540. The programs are available for \$45-\$75 or may be rented from \$10-\$15.

These programs would make an excellent supplement to the safety sections of this manual.

A general word on safety: Painters often resist using safety equipment saying that it is too uncomfortable and too hot; that it slows down production. Their lives are at stake and so is yours. Enforce the rules. You have the backing of the law.

Equipment/Aids

Slide projector and screen
Hypodermic needle gage and blast nozzle attached to a short length of hose
Respirators: mask, cartridge, air-fed
Protective clothing
Recommended: Video cassette equipment (optional)

References

For further information on topics in this unit, you may wish to refer to the following references:

1. Shipyard Industry OSHA Safety and Health Standards (OSHA 2268) January 1976.
2. American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XIII, Rules for Construction of Unfired Pressure Vessels, 1963.
3. Respiratory Protective Equipment, Data Sheet 444 Revision A, National Safety Council, 1969.
4. Abrasive Metal Finishing, Employee Health and Safety Practices NIOSH (DHEW) March 1976, HEW Publication No. (NIOSH) 76-144.
5. IBPAT/Occupational Safety and Health Training Project, 1978.

Discussions/Group Work

- Topic 3. Demonstrate the proper use of the hypodermic needle gage in the classroom. If possible, arrange for trainees to take measurements on an operating unit.
- Topic 6. Safe Practices. Many yards have safety and health training programs. Consider inviting the health and safety officer to attend this session to answer specific questions of concern to the painters and blasters.

Unit Quiz

A 20-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz B-IV:

- | | | | | |
|------|---------|-------|----------------|-------------|
| 1. A | 6. A, C | 11. F | 16. B, E, K | 21. C, F, I |
| 2. C | 7. A | 12. T | 17. J | 22. D, M |
| 3. B | 8. F | 13. F | 18. E, B | 23. E, M |
| 4. C | 9. T | 14. F | 19. C, E, F, I | 24. C, D, G |
| 5. D | 10. T | 15. T | 20. A, K | |

Matching.

Match the appropriate protections (Column 2) with the safety or health hazard (Column 1). There may be more than one appropriate protection for each hazard. Answers may be repeated.

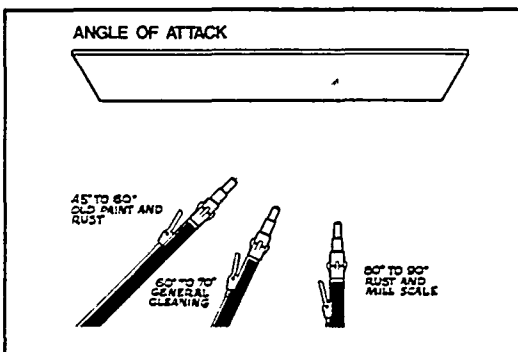
<u>Column 1 - HAZARD</u>	<u>Column 2 - PROTECTION</u>
16. Dermatitis _____	A. Goggles
17. Hearing Loss _____	B. Skin Cream
18. Chemical Burns _____	C. Ventilation
19. Toxic Effects to Nervous and Digestive Systems _____	D. Grounding
20. Eye Injury _____	E. Protective Clothing (including gloves, shoes, coveralls)
21. Respiratory Diseases _____	F. Air-fed Respirator
22. Electric Shock _____	G. Prove Area is Gas-Free
23. Heat Burns _____	H. Deadman Remote Control Valve
24. Fire/Explosion _____	I. Cartridge Respirator
	J. Ear Plugs
	K. Hood
	L. Safety Belts/Lines
	M. Insulation of Metal Parts

EFFICIENT AND SAFE PRACTICES
FOR SURFACE PREPARATION

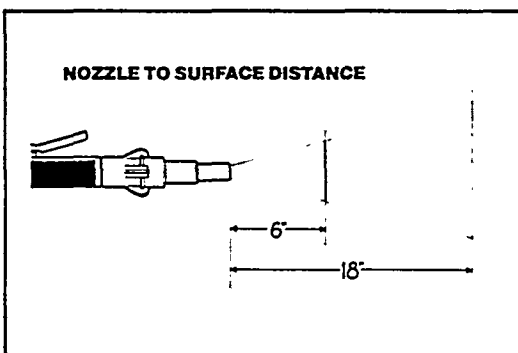
For effective nozzle operation, the blaster must determine the

- proper angle of attack and
- proper distance between the nozzle and the surface.

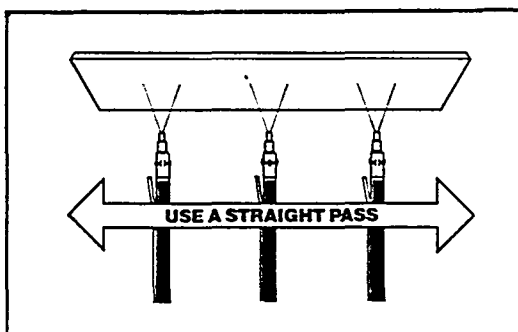
Experience is the best teacher. Experimentation with different angles and distances when starting a new job will determine what is most effective for that surface condition. Once the most efficient angle and distance are determined, the blaster should maintain them with each pass during the entire operation.



Angle of attack. The angle of the nozzle to the surface can range from 45° to 90° degrees. To remove rust and mill scale, the nozzle should be held between 80° and 90° to the surface. This is also preferred for dislodging contaminants from pitted surfaces. A slight downward angle will direct the dust away from the operator and will ensure better visibility. A sharp angle of attack, 45° to 60°, allows the operator to peel heavy coats of old paint and layers of rust by forcing the blast under the crust. A shallow-angle attack on this kind of surface would cause the abrasive to bounce back from the surface and the blasting would be less effective. General cleaning usually calls for a 60°-70° attack angle.



Nozzle to surface distance. The closer the nozzle is held to the surface, the smaller the blast pattern (the area hit by the abrasives) becomes. With a small pattern, the abrasives are concentrated in a smaller area, make impact at a greater speed, and have more force. On a small area, the operator can blast more crust for the energy spent, but will cover less area in a given time. A distance of only 6 inches may be required to remove tight scale. To blast old paint, 18 inches from the surface should be effective.

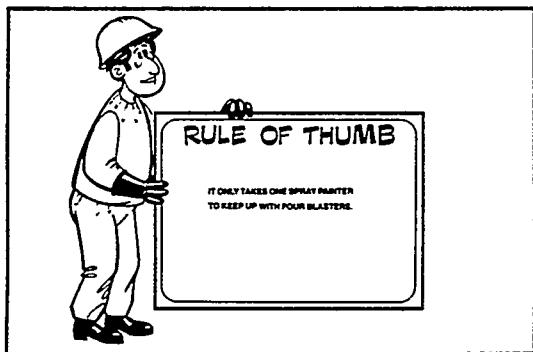


Each pass should be straight and at the same distance to produce work of uniform quality. There should be no arcing or varying the distance from the surface.

2. DETERMINING THE SIZE OF THE AREA TO BE BLASTED

The size of the surface area to be blasted at one time should never be more than can be primed the same day.

Blast clean small sections and protect these with primer immediately. Do not blast a large steel section and leave it exposed. In humid areas rust bloom or flash rust may be seen on the exposed surface within hours. The work of removing this before painting is an unnecessary expense.

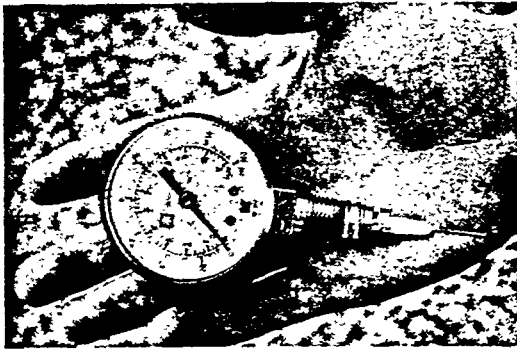


RULE OF THUMB

It only takes one spray painter to keep up with four blasters.

3. HOW TO MEASURE AIR PRESSURE

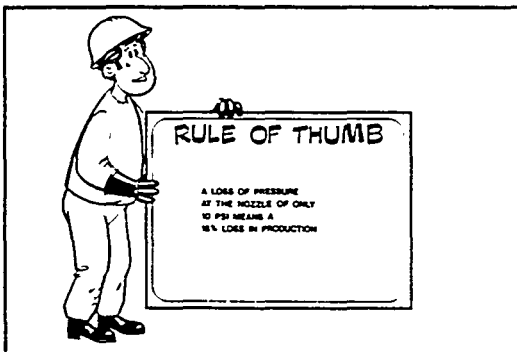
Reading the gage on the compressor or on the blast pot tells the pressure at those points only, NOT at the surface where the work is being done. If two or more lines are run off the same compressor, the pressure gage might read 90-100 psi but that is NOT the pressure available at the work surface. Leaking hoses, friction losses, and poor set-up also account for lowered pressure at the nozzle.



A hypodermic needle gage is used to measure air pressure at the nozzle. Air pressure must be measured as close to the nozzle as possible. Ideal pressure for efficient blasting is between 90-100 psi.

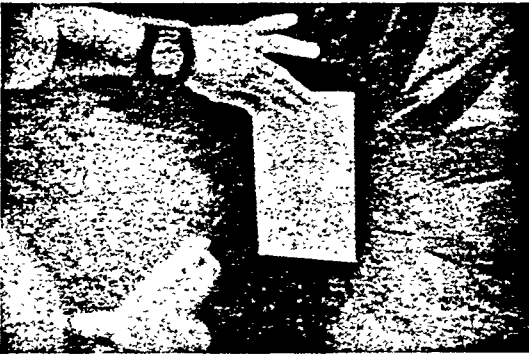


Insert gage into the blast hose as near the nozzle as possible. The needle must point in the direction of the abrasive flow. The measurement is made while the abrasive is flowing to give a true reading of the pressure of the air/abrasive mix which hits the surface. Check the readings at the start of every shift.



RULE OF THUMB

A loss of pressure at the nozzle of only 10 psi means a 15% loss in production.



The air used for blast cleaning affects the quality of the job. Air which carries dirt and oil defeats the purpose of blast cleaning. The air as well as the abrasives must be clean and oil-free. Water in the blast stream can cause spot rusting on steel.

Water and oil separators on the compressor and blast pot will solve the problem. They require regular attention.

Cleanliness of the air supply can be measured by a blotter test. Simply hold a plain white blotter 18 inches in front of the nozzle with only the air flowing for 1 to 2 minutes. (The abrasive flow must be turned off.) Stains on the blotter indicate dirt or oil in the air supply. Check the oil and water filters on the compressor and/or blast pot. A clean blotter means a clean air supply.

Oil, moisture, and other contaminants must be removed from the abrasive material for two important reasons:

- to prevent contamination of the cleaned surface, and
- to prevent clogging of the blast nozzle.

Abrasive contamination is of particular concern when the material is to be recycled. It may also be a problem when fresh abrasive supplies have been improperly stored. It is good practice to keep abrasives sealed in their original bags until ready for use. They may be stored off the ground on wooden palettes and, if left outdoors, covered with a plastic sheet.

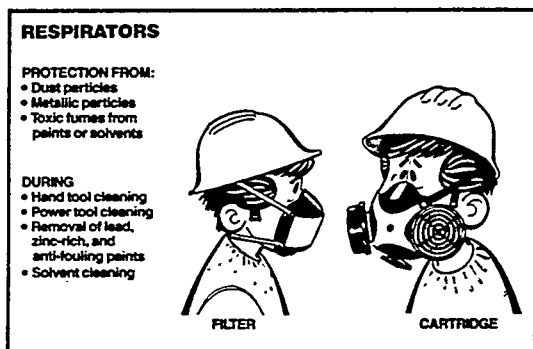
Abrasives carrying oil or water will stain and spot-rust a steel surface. The cleanliness needed for paint to bond cannot be achieved. If sand is the abrasive, it may mix with the water to clog the hose and nozzle. If steel shot or grit is the abrasive, excessive dampness may cause rusting.

To check the cleanliness of the abrasive, place a small amount of abrasive in a glass jar filled with water. Shake the glass. If an oil film appears on the surface of the water, the abrasive is not clean and should not be used.

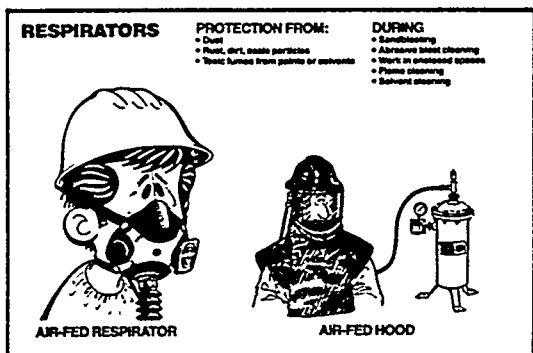
The dangers which may be present in surface preparation operations are minimized when safety and health precautions are carefully observed:

Recent studies by NIOSH and the International Brotherhood of Painters and Allied Trades have found that the hazards to the health of painters are significant. For example, 45% of the painters and blasters surveyed reported nose, mouth, and upper throat irritations due to solvents and dust; 38% of the blasters had chronic bronchitis; and 83% reported symptoms associated with solvent intoxication such as dizziness, muscle spasms, and loss of peripheral vision.

While there is a variety of potential hazards faced by blasters and other operators, there are many safety precautions, which can be taken to avoid accidents and illness. Understanding the function and capabilities of protective devices is your responsibility. Your health depends on using these devices correctly.



Respiratory problems. One of the most common health hazards facing operators is respiratory disease due to dust or toxic fumes. When using hand and power tools on new steel a filter or cartridge type respirator should be worn. To remove lead, zinc-rich, or anti-fouling paints, it is especially important to wear a filter-type respirator to trap the metallic and other dangerous particles.



In abrasive blast cleaning, a great amount of dust is generated by the breakdown of the abrasive on impact with the surface and the breaking up into very fine particles of the rust, dirt, scale and other contaminants. Blasters must use air-fed respirators and hoods, especially if they are working in enclosed spaces.

Where sandblasting is still used, the dangers of silicosis make the use of an air-fed respirator a must. Removal of coatings containing asbestos fibers can also lead to bronchial problems if use of respirators is ignored.

Air-fed respirators must also be employed when there is a danger of breathing toxic fumes. OSHA shipyard requirements state that workers removing coatings by flame cleaning in enclosed spaces must be protected by air-line respirators and in open air by fume filter type respirators.

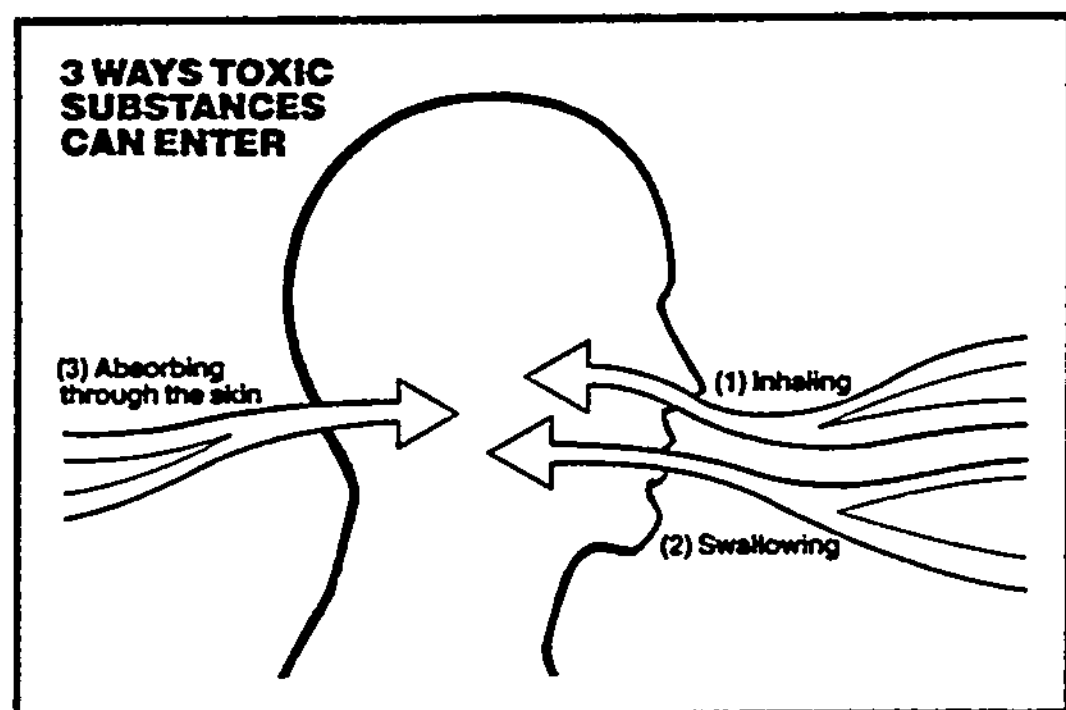
In solvent cleaning operations, either cartridge masks or air-fed respirators may be used. The choice is determined primarily by the kind of solvent used and whether the operation is taking place in an open or enclosed space.

In order to be effective, all respirators must fit properly and be carefully maintained. Your employer should instruct you in how to wear and care for your respirator. They must be kept in top working condition. Clean and check them after each use and replace filters on cartridges as soon as necessary. They should be stored in a clean, dry container in a place that is free from exposure to solvents or other harsh cleaning compounds.

When using air-fed respirators, the source of air must be monitored and controlled. It must meet specifications defining cleanliness and minimal acceptable concentrations of carbon monoxide, carbon dioxide and condensed hydrocarbons. If the fresh air used in oil-less compressors meets these standards, the delivered air will usually be acceptable. With oil-lubricated, piston type compressors, oil contamination and carbon monoxide released by overheating may contaminate the clean air. A high temperature alarm and routine testing for carbon monoxide is necessary. Minimum air supply requirements are 4 cfm of breathable air at pressures under 40 psi.

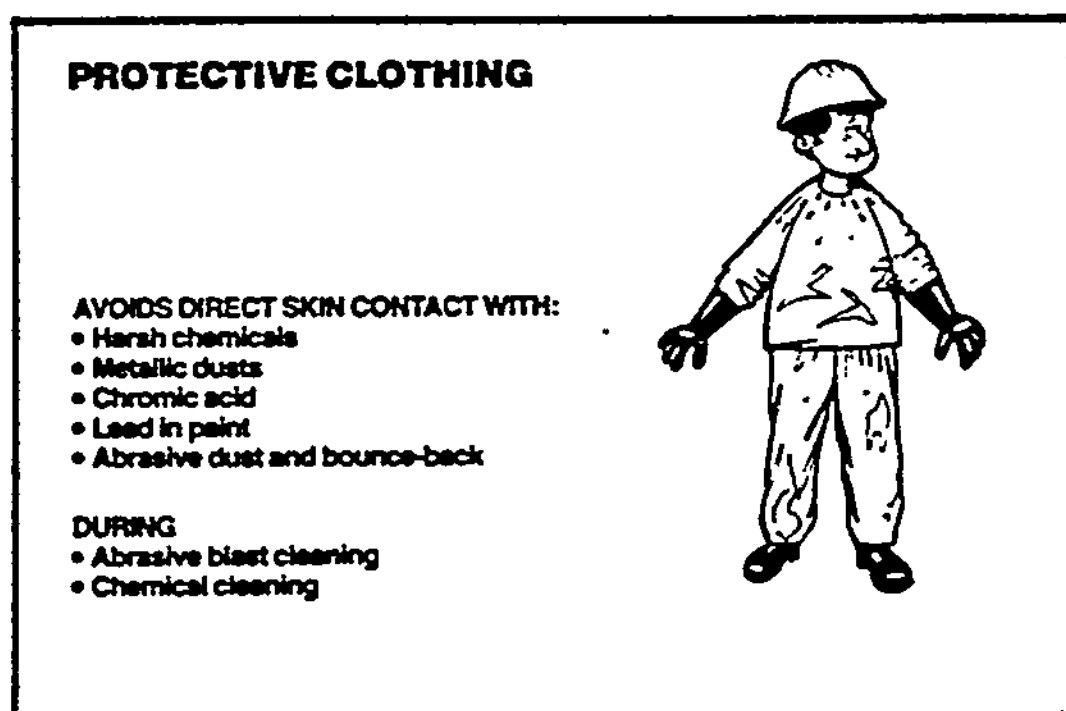
Adequate ventilation must be provided in all surface preparation situations. Flame cleaning may generate toxic fumes when old paint and surface contaminants are heated. In the use of chemical paint removers, either natural ventilation or mechanical exhaust ventilation must be sufficient to remove toxic vapors at the source and to dilute the concentration of vapors in the working space.

The dust generated by blast cleaning must also be removed from the workplace by means of a ventilation system. Dust and other particles should not be exhausted where they will enter the suction area of fans or drift into other work areas. Ventilation also increases visibility inside a tank or other confined area, allowing more rapid and efficient blasting, because the blaster can see what he is doing.



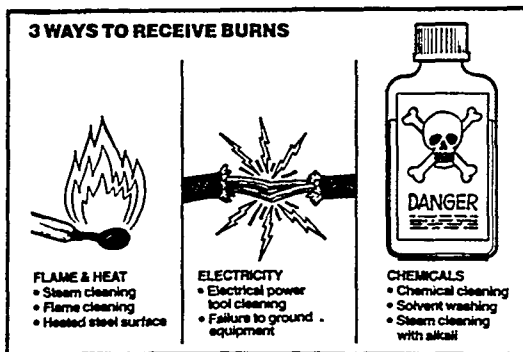
Toxic effects. Toxic, or poisonous, substances and fumes can enter the body in several ways. They can be inhaled, swallowed, and absorbed through the skin. Damage can be done to the nervous and digestive systems which may not be apparent for many years. Examples of this may be lung diseases such as silicosis and many forms of cancer. Other toxic effects are immediate. Symptoms such as headaches, coughing, rashes and dizziness appear soon after contact with a poisonous substance.

Proper choice and consistent use of respirators and protective creams and clothing shield the body from these harmful substances. Adequate ventilation in the work area also reduces worker exposure to problem substances.



Skin disease. Skin irritation is also a common problem among blasters. Skin rashes, also called dermatitis, can result from direct contact with an irritating chemical or certain metallic dusts. Lead poisoning can be caused by absorbing toxic dust through the skin. In chemical cleaning, burns and dermatitis can result from contact with chromates or chromic acid.

Skin irritations can be prevented by using protective skin creams and protective clothing, including heavy duty gloves. Abrasive blast cleaning also demands the use of protective clothing to protect all parts of the body from irritating dusts and abrasive bounce-back.

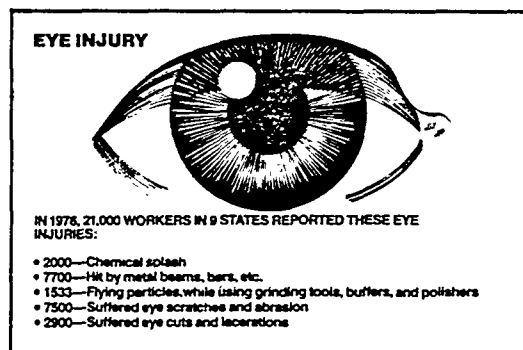


Burns. An operator can receive burns from heat, electricity, or from direct contact with chemicals. Flame cleaning requires particular care to avoid accidental burns from the flame or from the heated steel surface which reaches a temperature around 300°F. In steam cleaning, OSHA requires that the metal parts of a steam gun be insulated to protect against heat burns.

Chemical burns are a hazard when the skin comes in direct contact with harsh, harmful chemicals, as in solvent cleaning. Rubber gloves should always be worn in this operation. Other protective clothing, such as coveralls and boots, can prevent solvent splashing from burning other areas of the body.

Steam cleaning involves the possibility of burns from the steam under very high pressure. When alkali is in the steam, any burns received will be even more severe. To guard against these hazards a face shield, gloves and a protective rain suit must be worn.

All electrical power cleaning tools must be effectively grounded to prevent sparking and electrical burns. The equipment should be inspected for safe operating conditions. Tools with faulty plugs or broken wires may short-circuit causing electrical burns and/or fire.



Eye injury. In 1976, 21,000 eye injury cases were reported by workers in nine states. These were impact injuries; that is, eyes were struck by or against objects, or experienced chemical splash. Frequent sources of these injuries were due to

- flying particles while using grinding, polishing, and buffing tools (1,533 cases);
- being struck by metal beams, bars, etc. (7,700 cases); and
- chemical splash (2,000 cases).

Eye scratches and abrasions were reported by 7,500 workers, while 2,900 suffered cuts and lacerations.

EYE PROTECTION

EYE GOGGLES PROTECT AGAINST:

- Dust
- Flying particles or chips
- Chemical splash
- Abrasive bounce-back



Eye protection is an important precaution that must be taken during any surface preparation operation, especially where dust is generated and where particles bounce off the surface. Flying particles or chips from the surface which can blind or cause serious eye injuries are a problem with both hand and power tools and safety goggles must be worn. Safety goggles can also prevent dangerous solvents from splashing into eyes during chemical cleaning. Flame cleaning operations also require the use of safety goggles.

Hoods provide a greater degree of protection from dust and flying particles, shielding the eyes, face, neck and ears. In blasting, they protect the operator's eyes and head from abrasive ricochet.

HEARING PROTECTION



IN 1976, IN ONLY TWO STATES, 328 WORKERS EXPERIENCED HEARING LOSS

Hearing loss. Hearing loss can occur after exposure to high noise levels for long periods of time. In 1976, 328 workers experienced some loss of hearing in two states alone. There also were many similar job-related cases reported in the other 48 states.

HEARING PROTECTION

EAR PLUGS PROTECT YOUR HEARING WHILE USING CHIPPING HAMMERS AND BLASTING EQUIPMENT.



The use of chipping hammers and blast equipment are two surface preparation operations which can result in excessive noise. Ear plugs should be worn in areas where these and other operations with excessive and continuous noise levels are taking place.

Fire and explosion. The possibility of fire and explosions is a safety hazard faced by all surface preparation operators. Hand and power tools must be non-sparking and explosion-proof, especially in the presence of combustible vapors. Some abrasives can cause sparks when the particles strike the surface. If work is being done in a confined area, such as a tank, it must be proven gas-free. Sparks flying in an area containing flammable materials or combustible vapors present a potential explosion or fire hazard.

With an open flame present in flame cleaning, no flammable gases or volatile solvents should be present. In addition, priming the surface should follow flame cleaning only at a safe (far enough) distance with adequate ventilation.

In the use of chemical cleaning agents or volatile solvents adequate ventilation is always called for.

OSHA requirements state that "suitable fire extinguishing equipment shall be immediately available in the work area and shall be maintained [ready] for instant use."

Accidents. Safe use of all surface preparation equipment will reduce the occurrence of accidents. All equipment should be inspected for good working condition.

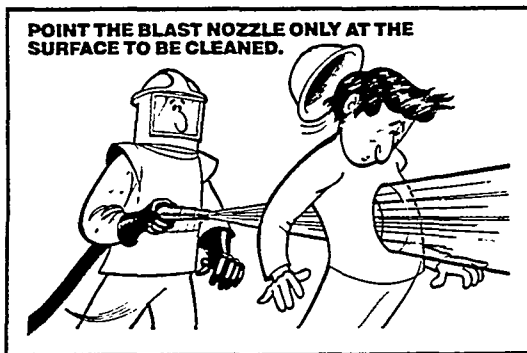
In accordance with OSHA rules, faulty hand and power tools, such as cracked grinders and wheels or damaged rotary brushes and wires must not be used. Pieces flying off of disintegrating abrasive wheels or broken wires can cause serious injury to an operator. All power equipment should be held correctly and operated at the speed recommended by the manufacturer. Where necessary, tools should be effectively grounded.

The pressure of the tank used in abrasive blast cleaning must be carefully watched to make sure it does not exceed the maximum allowable pressure for the pot. "Sandpots" fall under the category of unfired pressure vessels and must meet standards set by ASME (American Society of Mechanical Engineers).

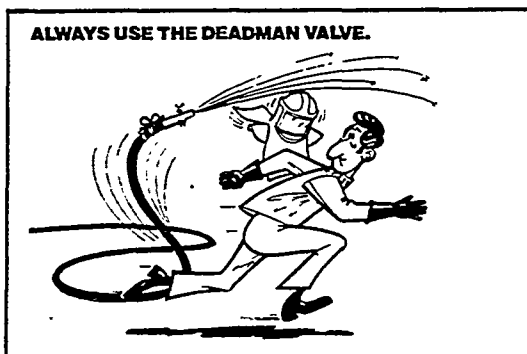
During solvent cleaning, care should be taken to prevent splashing the chemicals. Machinery parts will be destroyed and scaffolding ropes will be weakened, which could result in a serious accident.

Electric shock can occur in certain situations. In blast cleaning, the nozzle should be grounded so it will not discharge high static electricity and shock the blaster. The shock itself is not lethal but falling off a scaffold may be.

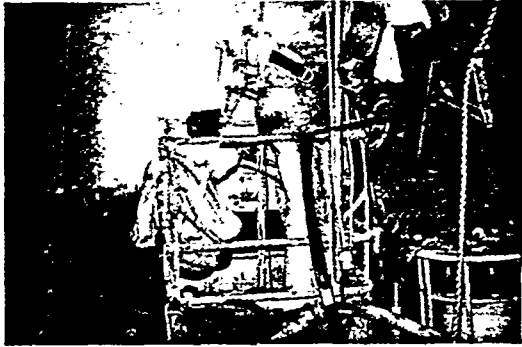
In waterblasting, electric shock can be conducted through wet surfaces. All electrical operations should be shut down when waterblasting is in process.



All equipment for surface preparation must be used correctly and only for the intended purpose. "Horseplay" on the job should never take place. Pointing a blast nozzle or a flame torch at a person, even in fun, can be a deadly mistake. The powerful force of a blast stream is similar to a continuous-action shotgun which will cut ropes and other rigging, so it should never even come near a scaffolding. Powerful equipment should never be pointed at anything other than the surface to be cleaned.



Blast cleaning requires that some special precautions be taken to avoid accidents. Deadman remote control valves, placed close to the blast nozzle, have been designed for the safety of the blaster. Always use this valve. Do not tie it down or keep it in the "on" position. When the valve is released, it shuts down the entire blasting operation. This eliminates the need for a second person watching the blast pot to stop the operation. It increases the blaster's control at the nozzle. If it is improperly used, the blaster may lose control, which might result in the loss of life or a limb. In addition, the blasting equipment should always be shut down before trying to clear an obstruction in the hoses or tanks.

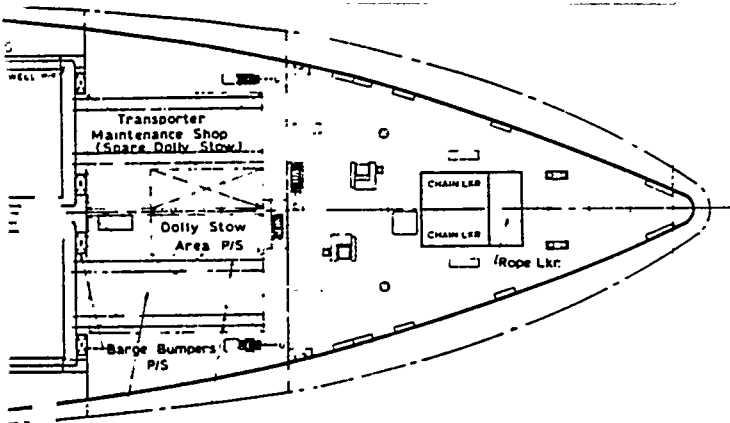


The use of safety belts and lines is an obvious precaution to take in any number of blasting situations above or below ground. Often their use is dictated by law. This is true when a blaster is working in a ship's hold or inside a chemical tank or grain elevator -- any situation where the blaster must be removed quickly in case of an emergency.

Where rigging of any kind -- scaffolding, swing stages, boatswain chairs, slings -- is used, safety belts and lines should also be used. The scaffolding and swing stage should have substantial guard rails. The force in a blasting pass tends to push the operator backward. Veteran blasters are always aware of this force and stand in a braced position to lessen its impact on them. Safety measures include back rails, stabilizing lines, and sure footing.

Should an accident occur, you should know where emergency phone numbers are posted and where emergency equipment and supplies are located. OSHA requires that a first aid kit is provided for each vessel that is being worked on. At least one employee should be qualified to give first aid, if there is no separate first aid room or health attendant.

Blasters and other operators should be aware of the dangers which are possible in their jobs. However, safe use of equipment and other precautions will prevent hazards from occurring. Thorough safety training is essential for efficient and productive workers.



PART B

QUIZ

UNIT IV

EFFICIENT AND SAFE PRACTICES FOR SURFACE PREPARATION

NAME: _____ DATE: _____ INSTRUCTOR: _____ GRADE: _____

Circle the most correct answer.

1. A hypodermic needle gage

- A. is used to measure air pressure at the blast nozzle.
- B. may be inserted anywhere along the hose to measure pressure.
- C. must not be used while the abrasive is flowing.
- D. can be used to measure blood pressure of a blaster.

2. Adequate ventilation must be provided

- A. only when there is a great amount of dust generated, as in abrasive blasting.
- B. only when using harsh solvents in an enclosed space.
- C. for all surface preparation operations.
- D. only when there is a danger of breathing toxic fumes.

3. The danger of electrical shock is not present in which operation?

- A. hydroblasting
- B. steam cleaning
- C. abrasive blasting
- D. power tools

4. Sandpots and other unfired pressure vessels must be closely watched to make sure

- A. they do not give off sparks.
- B. they do not get too hot.
- C. they do not exceed the maximum pressure allowed.
- D. they can be cleared of obstructions easily.

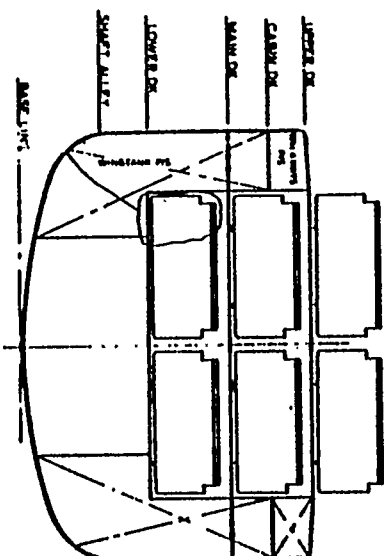
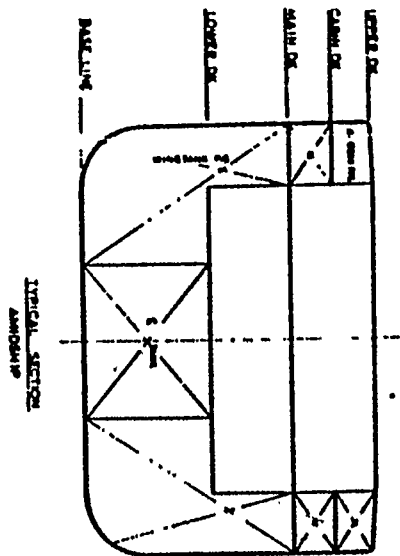
5. To remove tight mill scale, the blast nozzle should be held

- A. at least 18" from the surface.
- B. at a 45-60 degree angle.
- C. to give a large blast pattern.
- D. close to the surface, about 6" away.

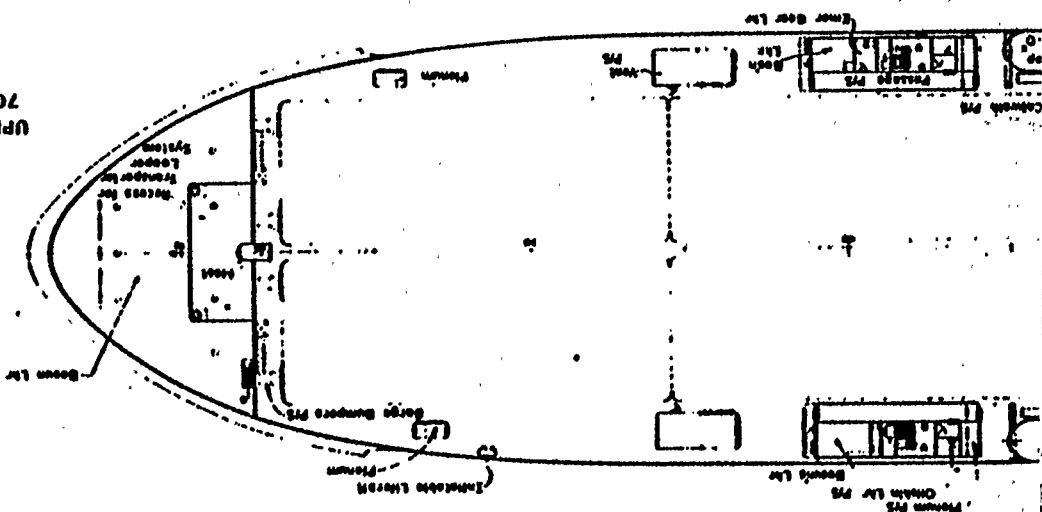
6. The two most important reasons for using clean abrasive materials are
- A. to avoid contaminating the cleaned surface.
 - B. to avoid breathing contaminated abrasives.
 - C. to prevent clogging the blast nozzle.
 - D. to keep the rest of the blast machinery clean.
7. A filter or cartridge type of respirator is effective protection against
- A. zinc rich paint particles
 - B. asbestos fibers
 - C. dust generated by blast cleaning
 - D. toxic fumes

Check the correct answer.

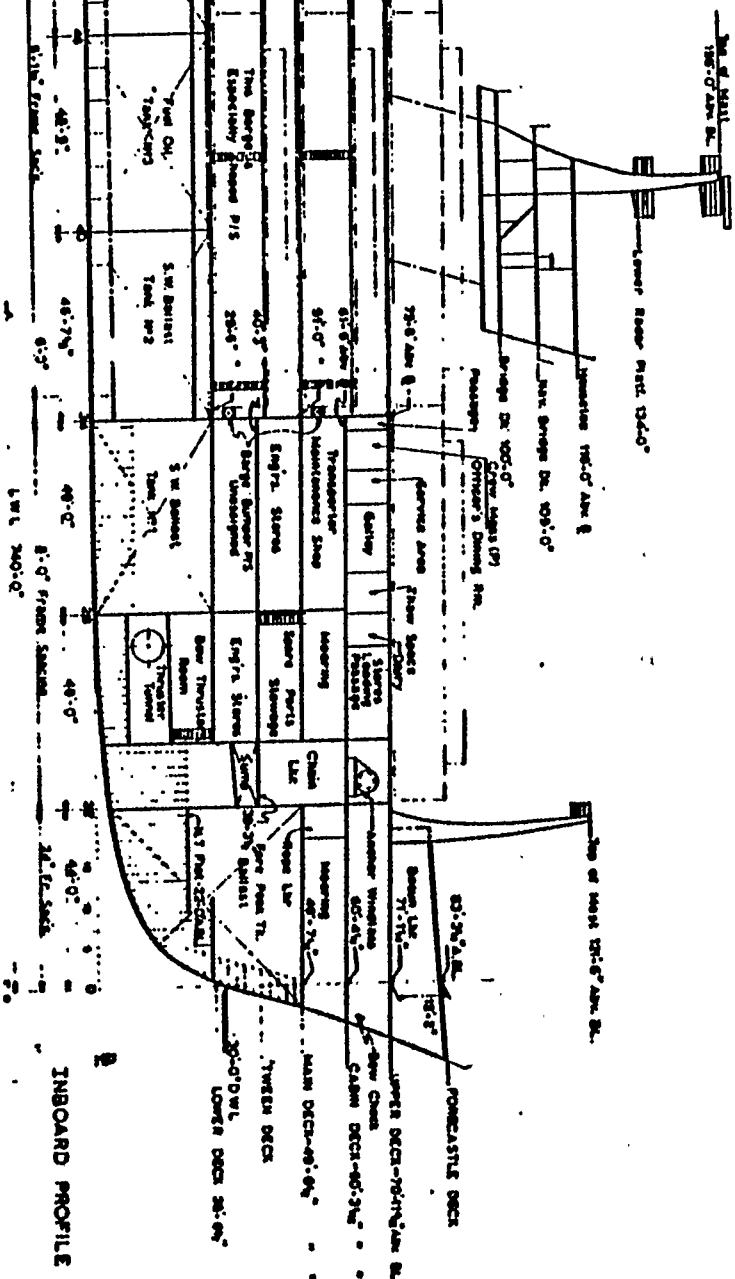
	<u>TRUE</u>	<u>FALSE</u>
8. Hearing loss is a hazard faced by all operators doing surface preparation work.	[]	[]
9. An air-fed respirator is effective protection against breathing harmful chemical fumes.	[]	[]
10. Some symptoms related to contact with toxic materials may not appear for several years.	[]	[]
11. For efficiency, as large a surface area as possible should be blasted in one day.	[]	[]
12. The gage on the compressor or the blast pot does not tell you what the pressure is at the surface.	[]	[]
13. The danger of burns is present only in the flame cleaning operation.	[]	[]
14. It is okay to point a blast nozzle at someone if the abrasive flow has been stopped by using the deadman remote control valve.	[]	[]
15. Protection against eye injury is important during all surface preparation operations, even those where no machinery or tools are in use.	[]	[]



SECTION AT 28 MPH
LWS Fwd.



UPPER DECK
70'-11 7/8\"/>



INBOARD PROFILE

PAINT AND SURFACE PREPARATION
TRAINING PROGRAM FOR SHIPYARD PERSONNEL

Part C: PAINT APPLICATION: TECHNIQUES AND PRACTICES

Unit I: Getting Ready to Paint

- TOPICS:**
- 1) Maintain Paint Quality Through Proper Storage
 - 2) Quality Paint Application Depends Upon Achieving Correct Viscosity
 - 3) Tips for Mixing One-Package Paints
 - 4) Tips for Mixing Two-Package Paints
 - 5) Ambient Conditions: Why and How to Measure Them

Unit II: Common Methods of Shipyard Paint Application

- TOPICS:**
- 1) Advantages of Using a Brush
 - 2) Use the Roller on Large or Confined Spaces
 - 3) Choose Spray Painting for High Production
 - 4) Comparison of Conventional and Airless Systems

Unit III: Set-Up and Efficient Operation of Spray Equipment

- TOPICS:**
- 1) The Basic Conventional Spray Set-Up
 - 2) Air Compressor Maintains High Production Rate
 - 3) The Paint Tank Helps Control Pressure
 - 4) Hose Sizes Affect Paint Delivery
 - 5) Adjusting the Spray Gun for Maximum Control
 - 6) Regular Spray Gun Cleaning and Lubrication Reduces Down-Time
 - 7) How to Correct a Faulty Air Nozzle Spray Pattern
 - 8) Field Demonstration of Set-Up and Shut-Down Procedure for Conventional Equipment
 - 9) The Basic Airless Spray Set-Up Has Only Three Major Parts
 - 10) Airless Spray Pattern is Controlled by Tip Selection
 - 11) Correcting Airless Spray Pattern Problems
 - 12) Field Demonstration of Set-Up and Shut-Down Procedure for Airless Equipment

Unit IV: Good Spraying Practices

- TOPICS:**
- 1) Proper Stroking Delivers Even Film Build
 - 2) Large Surfaces Require Sectioning and Overlapping
 - 3) Special Techniques for Inside and Outside Corners
 - 4) Proper Technique Reduces Film Defects
 - 5) Equipment Problems May Cause Film Defects

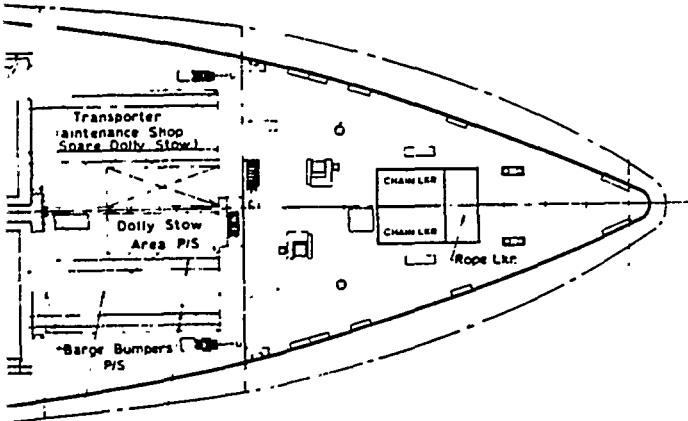
Unit V: Safety and Health Measures in Paint Application

- TOPICS:**
- 1) Protecting Yourself from Toxic Paint Materials
 - 2) Avoiding Mechanical Hazards Associated with the Use of Spray Equipment
 - 3) Reducing Danger from Fire and Explosion

PART C

PLANNING NOTES

UNIT I GETTING READY TO PAINT



Learning Objectives

After discussing this study unit, trainees should be able to:

1. Describe proper paint storage methods to avoid wasting paint and test the quality of paint which has been in storage.
2. Measure viscosity and then adjust a paint's viscosity to a specified measurement.
3. Mix one and two-package paints.
4. Measure ambient weather conditions and calculate dew points using psychrometric tables.
5. Explain the following key terms:
 - ambient temperature
 - shelf life
 - flash point
 - thixotropic paints
 - pot life
 - viscosity

Equipment/Aids

Slides, projector, screen, etc.
Zahn viscosity cup, stopwatch, mixed paint material
Cans of unmixed one and two-package paints, paddles, empty containers, strainers
Sling psychrometer, surface thermometer, Weather Bureau psychrometric tables

Discussions/Group Work

Topic 2. Measuring viscosity. Using a Zahn cup, demonstrate how to measure and control the viscosity of a material.

Topics 3 and 4. Demonstrate manual mixing and boxing of one-package paints and proper mixing of catalyzed paints. If you are training a group which is unfamiliar with painting practices, include a discussion and demonstration of:

- a. Proper lifting technique for 5 gallon drums. Lift with the strength of your legs, keeping the back straight.
- b. Proper removal of a 5 gallon drum lid. Caution the painters not to puncture the lid in case the can needs to be reclosed.

- c. Procedure for cutting off and disposing of any thin skin which may have formed over the top of the paint.

Topic 5. To measure the ambient conditions in the field, use a sling psychrometer, a surface thermometer, and psychrometric tables. Practice calculating dew point. Every trainee should participate in this exercise.

Unit Quiz

A 10-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz C-I:

- | | | |
|------|-------|-------|
| 1. D | 6. F | 11. F |
| 2. A | 7. F | 12. F |
| 3. C | 8. F | 13. T |
| 4. C | 9. T | 14. T |
| 5. D | 10. F | 15. F |
| | | 16. F |

PROPER STORAGE OF PAINTS

NO

- Flames
- Sparks
- Direct Sun

YES

- Temperature Control
- Stock Rotation
- On Pallets
- Ventilation

Proper paint storage can eliminate the waste of costly paint materials and is an important safety factor. Paints should be stored in a separate room or building away from the work area. The room must be well ventilated. Avoid excess heat, direct sunlight, sparks and flames to prevent fires due to explosions.

A paint's ability to burn is measured by its flash point. This is the lowest temperature at which a flammable liquid will give off enough vapor to ignite ("flash") when a flame or spark is present. Most paint solvents are flammable and many solvents have flash points below ambient ("surrounding") temperatures. When the concentration of solvent vapors reaches a certain level in the surrounding atmosphere, there is the possibility of explosion.

Paint is sensitive to temperature. Some paints that contain water (water emulsions) will be damaged permanently if they freeze. In cold weather, these paints should be stored indoors in a temperature-controlled room. If they freeze, they must be discarded.

Oil base paints and other types containing organic solvents may be stored outdoors. If the weather is cold, these paints should not be used until they are warmed to room temperature, ideally 70°F. Cold increases the thickness of paint and heat decreases it. Careful warming of the paint to the proper temperature will usually restore its consistency.

Paint cans should be kept in a dry area to prevent rust and contamination of the paint. The labels must be clear of paint and intact so that the contents are easily identified.

Do not open paint cans until they are needed for use. If they are opened before use, dirt and other foreign matter may contaminate the paint. Cans that have been opened for inspection or cans which have been partially used should be used before unopened cans. Air and dirt shorten the shelf life of the paint -- the maximum amount of time in which it may be stored and remain in usable condition. Never use paint which has exceeded its shelf life.

Paint that has been stored for a long period of time should be tested to see if the quality of the paint has changed. Some paints tend to curdle or gel after long storage. If lumps in the paint cannot be broken by stirring, throw the paint away. It is ruined and cannot be used.

To avoid wasting paint material, it is a good idea to develop a rotation system for receiving and using the paint. The paint that is received first should be used first. It should not be hidden behind newer paint cans or pushed to the back of the shelf. Adopt a method of "first in/first out" to avoid storing paints beyond their shelf life.

Some of the high performance paints are very costly. With some prices reaching up to \$30 per gallon, a yard cannot afford to discard any paint cans due to improper storage.

2. QUALITY PAINT APPLICATION DEPENDS ON ACHIEVING CORRECT VISCOSITY



Paint consistency is spoken of in terms of its "viscosity," a measurement of how fast or how slow a liquid flows. A high viscosity paint is thicker than a low viscosity paint.

Proper viscosity is essential for proper film build and corrosion protection. It is an important factor in selecting the proper equipment for spray application; obtaining good spray atomization properties; and obtaining satisfactory flow and leveling properties. The viscosity of each newly mixed batch of paint should be measured before it is applied.

3 FACTORS AFFECT PAINT VISCOSITY:

- Solvent/Solids Ratio
- Paint Temperature
- Paint Mixing

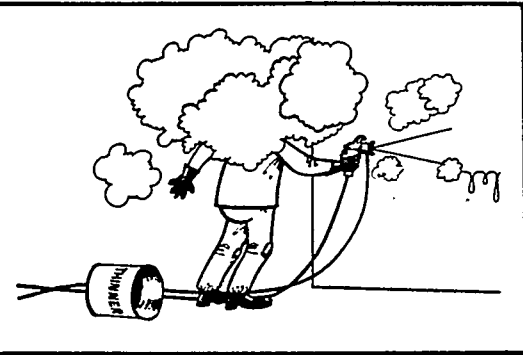
The three main factors which affect paint viscosity are

- solvent/solids ratio;
- paint temperature; and
- paint mixing.

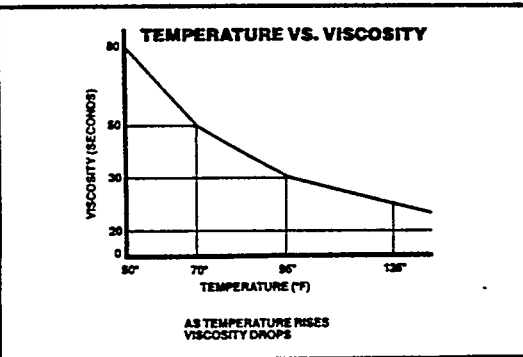
Solvent/solids ratio. Solvents are added by the paint manufacturer to dissolve the paint solids, both pigment and resin, to create a liquid which can be brushed, rolled, or sprayed. When the flow characteristics of a paint must be adjusted in the field, more solvent may be added. This extra solvent (or a similar or compatible solvent) which is added by the applicator according to the manufacturer's instructions, is called "thinner."

Add thinner to paint to decrease its viscosity only if the manufacturer's instructions clearly specify this step. Thinner addition is not always necessary. Most paints are formulated with the correct viscosity for spraying. The addition of thinner is seldom necessary.

In the past, one thinner may have been suitable for many paints. However, today's epoxies, urethanes, chlorinated rubber, and other specially formulated paints are more sensitive to heat, moisture, and correct thinning procedures. Following the instructions is absolutely necessary for adding the correct amount and type of thinner. If the wrong thinner is used, it may cause the paint to curdle or become lumpy. Once the quality of the paint is damaged, its original condition cannot be restored.

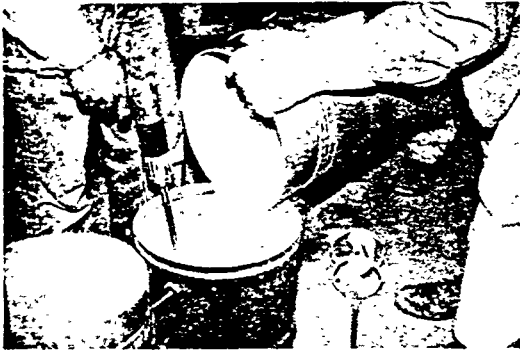


A paint with a large amount of thinner added will cover a larger surface area. However, once all the thinner evaporates, the film will be too thin. The paint will not have maximum hiding power and will not provide adequate surface protection. Repainting will be necessary. If the painter tries to build up a film thickness with overly-thinned paint, it will run and sag. Too much thinner in the paint also creates excessive spray fog. This is both dangerous to the painter's health and creates clean-up problems.



Paint temperature. Temperature variations may cause wide fluctuations in paint viscosity. For paints that have been stored in cold temperatures, warming is recommended to restore the original viscosity. Most paints should be applied at air temperatures between 50-90°F. Using conventional application methods, the best temperature range is 60-80°F. With airless equipment and certain solvent blends, material can be applied at 90°F. The temperature of the material should be at least as high as the surface to be coated.

Two-package paints are particularly sensitive to temperature. The chemical reaction which starts when the parts are mixed together accelerates at higher temperatures. This shortens the amount of time in which the paint can be applied and may affect the size of the batch to be mixed. Temperatures of the air, surface, or paint material that are too high severely shorten the pot life of the paint. Temperatures that are too low lengthen the curing time.

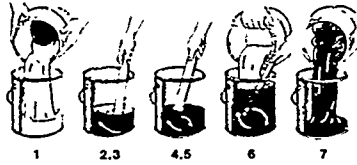


SLIDE OF TANK

Mixing. During storage, the paint pigments tend to settle at the bottom of the can. Mixing the paint thoroughly spreads out the settled pigments to give the paint the smooth, even consistency necessary for proper application. It also assures that the protective properties of the pigments are equally dispersed throughout the coating film. Failure to mix all of the settled solids changes the chemical balance of the paint. Leaving zinc dust at the bottom of the paint can, for example, means less galvanic protection for the ship. The surface may look well coated but it will not be well protected. Because the solids in some paints are so heavy that they quickly fall to the bottom again after mixing, the manufacturer may recommend the use of a constant motorized pot agitator. This is often the case with inorganic zincs and anti-foulants, two high-density pigment paints which require thorough mixing and constant agitation.

Some paints reach the proper viscosity by stirring or agitation. These paints are called "thixotropic," which means "false bodied." When the lid is first opened they appear to be unusually thick and gel-like. A stick can be plunged down through the center of the material creating a hole that will not fill up when the stick is removed. However, when the material is stirred, it becomes more liquid until it reaches the consistency necessary for application. This kind of paint material is ready for use when it reaches a consistency similar to heavy molasses. When the material stands un-mixed, it will return to its original gel-like state. Many thixotropic paints require constant agitation in the pot while being applied.

MIXING ONE PACKAGE PAINTS



Mixing paint can be done manually or mechanically. For a small amount of paint (up to 5 gallons) manual mixing is satisfactory.

For paint that comes in one container, the best method for mixing involves these steps:

Step 1. Pour off the thin portion of the paint into a clean container.

Step 2. Stir the settled portion with a strong, clean paddle to break up the settled pigment.

Step 3. Break the lumps by rubbing them against the inside of the can.

Step 4. Use a figure-8 motion to mix thoroughly.

Step 5. Follow with a lifting and beating motion.

Step 6. Gradually return the thin, poured-off portion to the original container while continuing to stir.

Step 7. When paint appears to be thoroughly mixed, it is "boxed." To box, pour the paint back and forth between the two containers until it reaches a smooth, even consistency.

Never use an air hose to mix paint. The addition of air drives off the solvents and changes the flow characteristics of the paint. Furthermore, the air stream is not sufficient to lift heavy pigments which will remain at the bottom of the paint can.

Only mix as much paint as necessary for a day's work. Care should be taken not to leave paint in buckets or spray pots overnight. Gather together unused paint and put it into one covered container. Re-mix the paint thoroughly before using the next day.

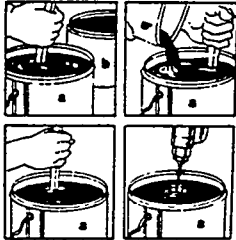
Follow the manufacturer's instructions for type and amount of thinner to be used. To determine the proper amount of thinning, first test the viscosity of the paint which has been specified for that paint job. Then add enough thinner to obtain the specified viscosity for application.

To determine if the paint has been thoroughly mixed, take a sample of paint from the bottom of the container and compare it with a sample taken from the top. If the paint is not mixed thoroughly enough, the paint from the bottom will be thicker due to a higher pigment concentration. When the paint appears to be consistent throughout, it is properly mixed. A fine wire mesh or screen will catch any remaining lumps which could clog the spray equipment.

4. TIPS FOR MIXING TWO-PACKAGE PAINTS

The catalyzed paints found most often in shipyards are epoxies and urethanes. These paints cure by an internal reaction of chemicals. Catalyzed paints come in two separate packages, which must be kept separate until the paint is ready for use. The larger package (A) is the base. The smaller package (B) contains the catalyst, or curing agent. Neither package may be used alone. The two packages must be combined before they can perform as a paint. If the catalyst (B) is not added to the base (A), the paint film will NEVER cure.

MIXING TWO PACKAGE PAINTS



To mix two-package paints, follow these steps:

Step 1. Stir package (A) to spread out the lumps of pigment that have settled. Use a clean paddle. Five minutes is usually adequate.

Step 2. While continuing to stir, slowly add all of package (B).

Step 3. Agitate the two combined parts until they are smooth in consistency, using either a manual or motorized agitator.

As soon as the two packages have been combined, the chemical reaction which leads to curing begins. Most paints must stand for approximately 30 minutes before they are set and are ready to apply. Some paints set very quickly, however, and can be applied immediately. This setting-up time, also called the "induction time," is very important for proper curing of the paint film.

POT LIFE



Once started, the chemical reaction cannot be stopped. It continues until the paint is completely cured. If the paint is allowed to stand for too long -- that is, beyond its "pot life" -- it will cure and harden in the spray pot, lines, and gun. The material becomes so hard that it cannot be removed and the equipment must be replaced.

Avoid wasting paint by only mixing enough for prompt use. In typical production spraying, a 5-gallon can will be used in one hour. Excess paint mixed at the end of a shift cannot be stored and re-used once its pot life has expired.

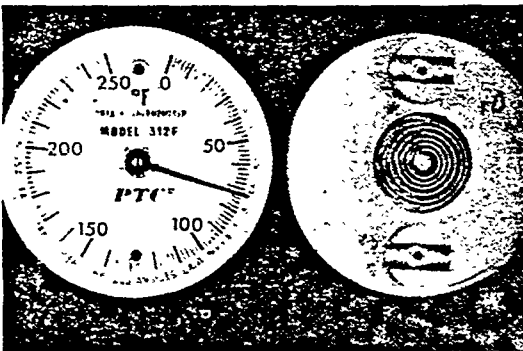
As with the one-package paints, straining should follow the mixing to catch any remaining lumps which could clog the spray equipment or ruin the surface finish.

While there are some special catalyzed epoxies that will react in cold conditions, most epoxies need a minimum temperature of 50°F to react. Both the surface temperature and the paint materials need to be at least 50°F. Above 90°F, reaction time of some materials is very rapid. Within ten minutes, an amine can react completely, i.e., harden to the point of being unusable. This "kickover" is accelerated at higher temperatures.

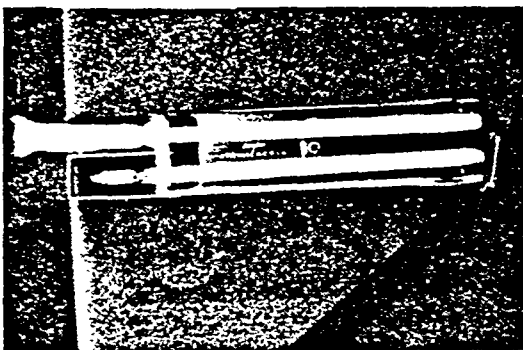
5. AMBIENT CONDITIONS:
WHY AND HOW TO MEASURE THEM

Before any paint can be applied, the painter must check the "ambient" or surrounding weather conditions. This is especially important in the early morning, when the weather is changing, or during seasonal changes when condensation is common. While a thin film of condensed moisture may be invisible on the steel surface, there is no run-off for water. A quick check of the dew point and surface temperature will determine if painting can begin.

Dew point is defined as the temperature at which moisture condenses on a surface. Paint should not be applied unless the surface temperature of the steel is at least 5°F above the dew point. This temperature should be maintained throughout curing.



The temperature of the steel is measured with a thermometer which has a magnetic clip to hold it onto the surface. A direct dial reading is taken. Dew point is not read directly from a gage, but it is easy to calculate using a "psychrometer" and appropriate weather bureau tables.



A psychrometer may be hand-operated or motorized. The working principle is the same. It contains both a dry bulb and a wet bulb thermometer. After the "sock" or wick is thoroughly wetted, air is circulated around the thermometer either by whirling the "sling psychrometer" or switching on the fan of the motorized instrument. Carefully watch the mercury column in the wet bulb thermometer. Take several readings to obtain agreement on the lowest reading possible. Record this and the reading on the dry bulb thermometer.

Temperature of dew point in degrees Fahrenheit-											
[Pressure=30.0 inches]											
Air temperature t	Vapor pressure e	Depression of wet-bulb thermometer (t-t ¹)									
		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
55	0.432	54	53	52	51	50	50	49	48	47	45
56	.448	55	54	53	52	51	50	49	48	47	46
57	.465	56	55	54	53	52	51	50	49	48	47
58	.482	57	56	55	54	53	52	51	50	49	48
59	.499	58	57	56	55	54	53	52	51	50	49
60	0.517	59	58	57	56	55	54	53	52	51	50
61	.536	60	59	58	57	56	55	54	53	52	51
62	.555	61	60	59	58	57	56	55	54	53	52
63	.575	62	61	60	59	58	57	56	55	54	53
64	.595	63	62	61	60	59	58	57	56	55	54

It is important to choose the proper table to determine the dew point. The psychrometric tables are calculated at different barometric pressures. If the barometric pressure at the yard is unknown, use the 30-inch pressure table. Find the dry bulb temperature (t) in the left column. The numbers across the top of the table are the difference between the dry and wet bulb readings (t - t¹). For example: If the dry bulb reading is 63°F and the wet bulb reading is 59°F, what is the minimum surface temperature needed for painting to begin?

$$\text{dry bulb} = t = 63^{\circ}\text{F}$$

$$\text{wet bulb} = t^1 = 59^{\circ}\text{F}$$

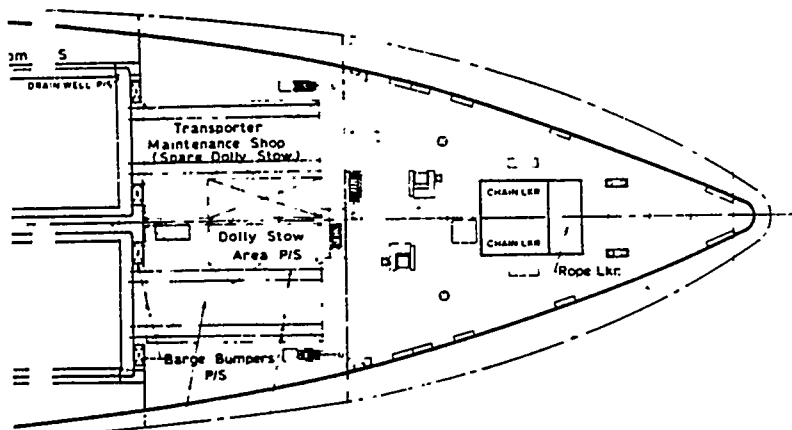
$$(t - t^1) = 4^{\circ}$$

Referring to the 30" tables, the dew point is 56°F. Painting may begin when the temperature of the steel surface reaches a minimum of 61°F.

DISCUSSION NOTES

When using a sling psychrometer, the whirling motion should be medium speed and steady. Do not jerk the instrument or allow it to strike the body or other objects. A first reading may be taken after 15 or 20 seconds but a minute or more may be needed to obtain the correct minimum temperature.

The water used to wet the sock should be at air temperature. Field cases often contain a small vial for carrying water for the wick which must be completely saturated when used. On very cold days the wet bulb may fall below the freezing point although the water remains liquid. Take the lowest reading, as it remains accurate. However, should the water suddenly freeze, the temperature of the wet bulb will immediately become 32°F. It is important to keep whirling the instrument until the ice-covered bulb has reached a minimum temperature.



PART C

QUIZ

UNIT I

GETTING READY TO PAINT

NAME:

DATE:

INSTRUCTOR:

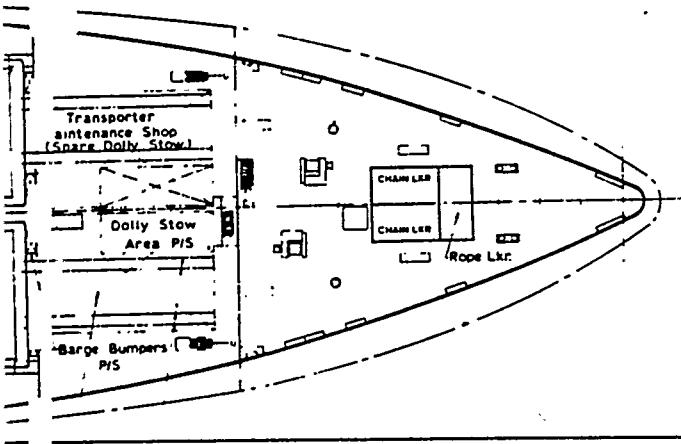
GRADE:

Circle the most correct answer.

1. A "first in/first out" rotation method
 - A. avoids storing paints beyond their pot life.
 - B. is a standard union seniority system.
 - C. improves paint viscosity.
 - D. is a rotation system which avoids wasting paint.
2. The "flash point" of a paint
 - A. is the lowest temperature at which enough solvent vapor will be driven off to burn if a spark or flame is present.
 - B. is the highest temperature needed to cause an explosion.
 - C. is only important if a paint is stored beyond its shelf life.
 - D. may be decreased by proper ventilation.
3. Paints which reach their proper flowability by stirring NOT by thinning are called
 - A. viscous
 - B. catalyzed
 - C. thixotropic
 - D. curdled
4. Paint thinner.
 - A. A smart painter knows exactly how much thinner to add.
 - B. Thinner must be the same material as the solvent.
 - C. Using the wrong thinner or too much thinner can destroy some paints.
 - D. Mineral spirits are the "universal solvent."
5. The amount of time needed for a mixed, catalyzed paint to initiate the curing reaction before it is ready for use is called
 - A. kickover time
 - B. pot life
 - C. down time
 - D. induction time

Check the correct answer.

	<u>TRUE</u>	<u>FALSE</u>
6. On hot days add only enough catalyst (part B) to get the chemical reaction started.	[]	[]
7. Only first shift inspectors bother to check for dew point.	[]	[]
8. Painting can begin as soon as the surface temperature and dew point are equal.	[]	[]
9. Dew point should be measured several times a day, especially when temperatures are dropping.	[]	[]
10. All paints should be thinned to improve their rate of coverage.	[]	[]
11. If paint has curdled in storage, strain out the lumps and use the remaining portion.	[]	[]
12. A high viscosity paint is easier to spray than a low viscosity paint.	[]	[]
13. Paint viscosity increases when temperature decreases.	[]	[]
14. The higher the temperature, the shorter the pot life of a catalyzed paint.	[]	[]
15. An air hose stuck in the paint can is a satisfactory way to mix heavy paints.	[]	[]
16. If mixed two-package paint is left over at the end of the day, gather it in one container for use the next day.	[]	[]



PART C

PLANNING NOTES

UNIT II COMMON METHODS OF SHIPYARD PAINT APPLICATION

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Compare the advantages of applying paint by brush, roller, and spray methods in different shipyard situations.
2. Explain the advantages and drawbacks of air and airless spraying. Consider economy, production speed, and quality.
3. Explain the following key terms:
 - atomize
 - overspray
 - bounce-back
 - skidding

Notes to the Instructor

CHOOSING A PAINT BRUSH OR ROLLER:

While simple, these are important tools in the painting trade. A professional quality natural bristle brush will give the finest finish with minimal brush marking. Bristle will splay in waterbase paints and is not preferred. Nylon will remain springy in water but may turn limp in hot temperatures. Here, polyester or nylon-polyester blend would be a better choice.

When applying paints containing strong chemical solvents, choose rollers with a sturdy phenolic core. If the solvent is capable of degrading the core, the roller will separate leaving bits of fiber in your coating film.

Equipment/Aids

Slide projector and screen

Demonstration:

- | | | |
|----------------------|---------------|-----------------------|
| - paint | - paint trays | - brushes |
| - clean-up materials | - rollers | - practice substrate* |

* For general demonstration purposes, Kraft brown paper tacked to a wall would be sufficient. For painter training, steel shapes, including I-beams, pipes, plates with welds and rivet heads, etc. would be more suitable.

Discussions/Group Work

1. A demonstration of proper preparation and use of a paint brush is part of Topic 1. When this unit is used for training supervisors, this will be a review and may be demonstrated by the instructor. If new painters are being trained, expand the time allowed and set up a sufficient number of painting stations to give each painter supervised practice time.
2. Topic 2 should include a similar demonstration of roller use and stroking.
Evaluate the following skills:
 - proper loading of brush and roller
 - brush out/roll out to obtain uniform film build
 - absence of lap marks
 - absence of skidding
 - horizontal and vertical stroking to provide complete coverage

Unit Quiz

A 15-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz C-II:

- | | | | |
|---------|-------|-------|-------|
| 1. C | 6. A | 11. A | 16. T |
| 2. D | 7. A | 12. F | 17. T |
| 3. B, C | 8. C | 13. F | |
| 4. D | 9. C | 14. T | |
| 5. A | 10. C | 15. T | |

COMMON METHODS
OF SHIPYARD PAINT APPLICATION

Brushing is an effective method of paint application because it works the paint into all the pores and dents of the surface. Because it makes very close contact with the metal surface, brushing can be a good method to use for applying the first coat of paint, called the "primer."

Because it is slow, however, brush application is primarily used for touch-up jobs and in small areas such as around rivet heads. It is not the appropriate method for painting a large area such as the exterior hull. It is also not effective for obtaining a uniform film thickness.

When using a brush, choose good quality natural bristles. Synthetic filaments which will not be destroyed by strong paint solvents are the second choice.



Avoid brushing the paint out too thin, as this will leave areas on the surface unprotected. Even if the second coat is more uniform in film thickness, the finished coating will have thin and uneven areas which will lead to early paint failure.



Apply the second coat of paint at right angles to the first coat. All following coats are also applied at right angles to the previous coat.

Proper use of a paint brush will help to spread the paint evenly across the surface with a minimum of effort. Once the right size and shape brush has been chosen, follow these tips for achieving a good coverage and a smooth finish.

Tips for Proper Paint Brush Use:

- Step 1. Shake loose any unattached bristles by spinning the brush between your palms.
- Step 2. Snap off any stray bristles. A putty knife will help here.
- Step 3. Dip the brush into the paint to cover $\frac{1}{3}$ of the length of the bristles. Do not cover the entire bristle length. The paint will fill the heel of the brush and run down the handle and operator's arm.
- Step 4. Remove excess paint by slapping the brush on the side of the can.
- Step 5. Paint with the tips of the bristles. Use a light touch. Don't press down hard on the bristles.
- Step 6. Always work from the dry to the wet surface. Do not pull the paint brush through wet paint to the unpainted surface.

A roller can be used for paint application on large areas, such as decks, and in interior areas where overspray presents a cleaning problem. In some cases, ship repair yards use this method for painting exterior hulls.

A roller should never be used to apply a primer. The paint will be applied over pores and dents and will not penetrate the surface well. When paint is rolled onto the surface, air can get mixed into the paint providing an ideal condition for corrosion to begin. Rolling may be used with good results after the primer has been applied by another method, such as brushing.

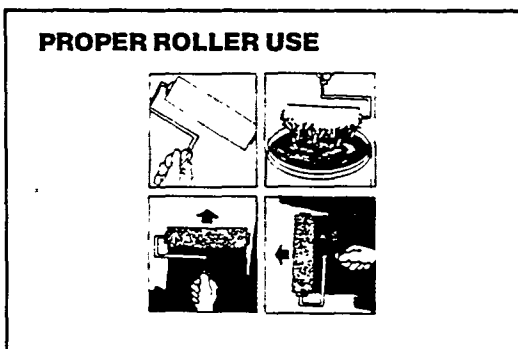
Tips for Proper Roller Use:

Step 1. For thick-bodied coatings, dip the roller directly into the paint container. For thin-bodied coatings, dip the roller into a roller tray.

Step 2. To apply the paint evenly, the roller must be properly loaded. Skidding or tracking will occur if the roller is too dry or is loaded with too much paint. Do not roll the paint out too thin -- the roller should have enough material to provide a sufficient film thickness.

Step 3. Do not apply heavy pressure -- it is not necessary.

Step 4. Apply the second coat at right angles to the first.

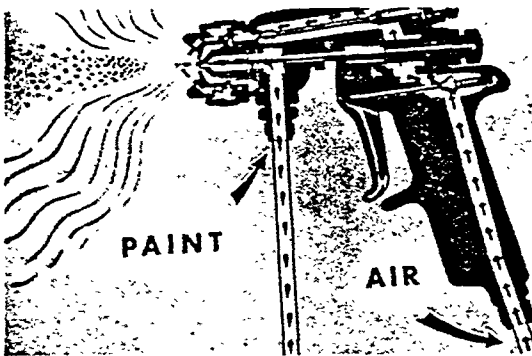


METHOD (square feet applied per 8-hour day)

Brush	1,000 sq. ft.
Roller	2 - 4,000 sq. ft.
Air Spray	4 - 8,000 sq. ft.
Airless Spray	8 - 12,000 sq. ft.

Spray painting is a preferred application method. It can provide a high, even film thickness in one coat with good appearance at an increased production rate.

Both conventional and airless methods of spray paint application are faster than brush or roller application. The paint supply is at hand through the gun, so there is no time spent dipping the applicator into a paint container. The time it takes to paint a large area is reduced greatly by spray application. For example, a painter using a brush can apply paint to 1,000 square feet in 8 hours. But, if he uses airless spray equipment, he can cover at least 8 times the area in the same amount of time.

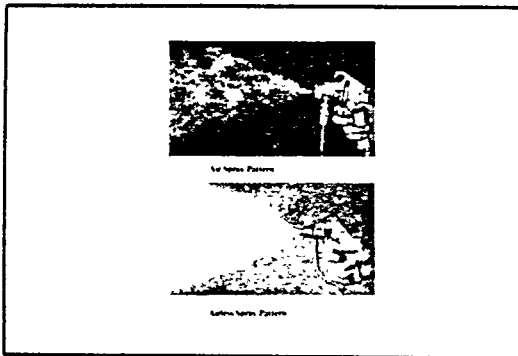


The conventional method relies on air for atomization. Jets of compressed air are shot into the stream of paint at the nozzle, breaking the fluid stream into tiny particles. The paint particles are carried to the surface on a current of air. Paint loss with this method due to "bounce-back" or "overspray," material that misses the object, can result in a loss of material as high as 30 to 40%.

4. COMPARISON OF CONVENTIONAL AND AIRLESS SYSTEMS

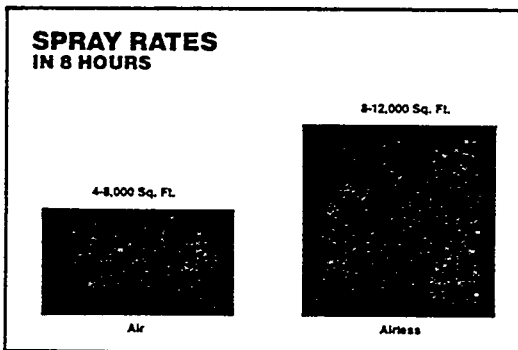
The main difference between the conventional and airless spray methods is in the way the paint fluid is "atomized" or reduced to a fine spray.

Air spray equipment has been in widespread use for over fifty years and refinements in equipment and regulating devices have made this system the most versatile spray painting system. Air spray provides great selectivity of pattern shapes with varying atomization and wetness of coat. Spray gun triggering is more easily controlled for precise spraying of shapes, corners, and pipes.



Conventional spraying provides a finer degree of atomization and a higher quality surface finish than the airless method. When a quick film build, greater surface penetration and rapid coverage are required in shipyards, airless spray equipment is preferred.

In the airless method, the paint is forced through a very small opening at the nozzle at very high pressure. Under this pressure, the paint is broken apart into tiny particles as it is released from the nozzle.



Because the airless method uses such high fluid pressure, the rate that paint can be applied is greater than with any other method of application. Airless spraying provides the fastest application speed and is an excellent method for painting large areas such as the exterior hull for this reason. For example, in an 8-hour period, a painter using airless spray equipment can apply paint to almost twice the area as is possible with conventional spray equipment.

When paint is forced out of an airless nozzle at high pressure, the only material that comes out is paint. The high pressure directs the paint into cavities and corners with little rebound from the surface. There is little danger of moisture or dirt from an air compressor ruining the finish. One airless coat of paint will often give greater film thickness than two air-sprayed coats.

The advantages of using airless spray over conventional spray can be summarized as follows:

Speed and Ease

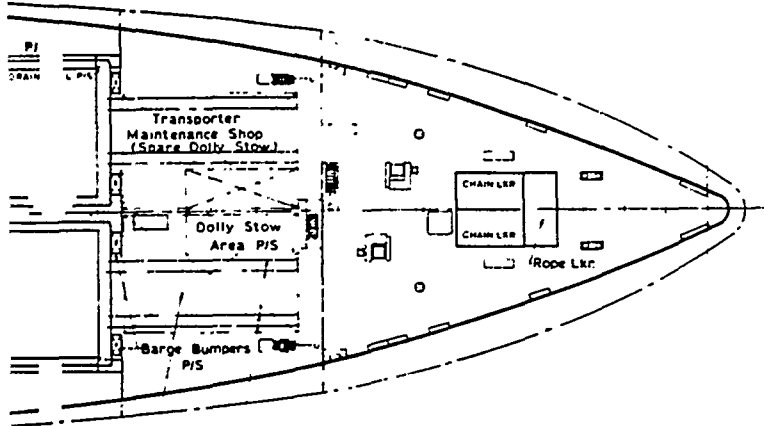
- The same coverage can be obtained with an airless spray gun with far fewer passes. One airless coat often gives greater thickness than two air spray coats.
- An airless spray gun can use a smaller compressor when small spray tips are used.
- An airless spray gun requires only one hose.
- No fine adjustments are required -- only proper tip and paint pressure.
- Clean-up and color change are much faster.

Quality

- The airless method atomizes most materials in an unthinned state, thus affording greater film build per coat, as well as faster drying.
- The force behind the airless atomized paint drives it into cracks, crevices, and corners more effectively. There is less air turbulence to cause paint to bounce-back from the surface.
- Because compressed air is not mixed with the paint, there is no danger of moisture becoming entrapped in the paint film.

Economy

- Bounce-back is reduced, resulting in paint savings.
- Clean-cut airless spray patterns go where they are aimed, so painters spend less time in masking and cleaning up.
- Because no compressed air is used in atomization, the airless method consumes only one-tenth the horsepower in atomizing a gallon of paint than an air spray unit consumes. Thus, a smaller, less expensive air compressor can be used with airless spray. If an electrically powered airless pump is used, an air compressor is not needed at all.



PART C

QUIZ

UNIT II COMMON METHODS OF SHIPYARD PAINT APPLICATION

NAME: _____

DATE: _____

INSTRUCTOR: _____

GRADE: _____

Circle the most correct answer.

1. Brushing is an effective method of applying paint because
 - A. it gives uniform film thickness.
 - B. brushes can be thrown away and are cheaper than spray equipment.
 - C. it works the paint into surface irregularities, around rivet heads, etc.
 - D. there is no bounce back.
2. A primer may be applied by
 - A. brushing
 - B. rolling
 - C. spraying
 - D. A or C
3. Rollers are not preferred for applying the prime coat because (Choose two.)
 - A. rolling is not as fast as spraying.
 - B. air often becomes trapped under the paint film.
 - C. rollers do NOT force the paint into surface dents.
 - D. "skidding" can occur.
4. Which statement is NOT an advantage of airless spraying?
 - A. Airless gives less bounce back.
 - B. Airless gives higher film build per coat.
 - C. Color change is faster with airless.
 - D. Airless gives a finer surface finish.

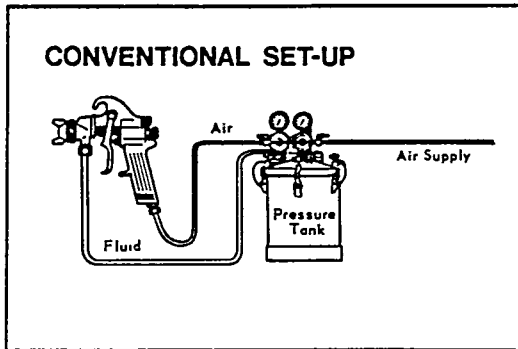
The following statements describe the advantages of conventional and airless spraying. If the statement is true for conventional (air spraying) mark a "C" in the right column. If it is true for airless mark an "A".

- | | |
|--|-------|
| 5. Tip plugging is a problem. | [.] |
| 6. Cannot spray paints with heavy pigments or fiber fillers. | [] |
| 7. Nozzle must be changed to change spray pattern. | [] |
| 8. All materials that flow can be sprayed. | [] |

- | | |
|------------------------------------|--------|
| 9. Less speed but greater control. | [] |
| 10. Low nozzle pressure. | [] |
| 11. Easier corner spraying. | [] |

Check the correct answer.

- | | <u>TRUE</u> | <u>FALSE</u> |
|--|-------------|--------------|
| 12. Cover the paint brush bristles to at least 2/3 their length; a full brush gives better coverage. | [] | [] |
| 13. In brushwork each coat of paint should be applied in the same direction as the first. | [] | [] |
| 14. Rollers are preferred in large confined spaces where overspray presents a cleaning problem. | [] | [] |
| 15. An uneven paint film - skidding - may be caused by too much or too little paint on the roller. | [] | [] |
| 16. Airless spraying is 8 times faster than brushing. | [] | [] |
| 17. Conventional spray equipment has lower maintenance requirements. | [] | [] |

SET-UP AND EFFICIENT OPERATION
OF SPRAY EQUIPMENT

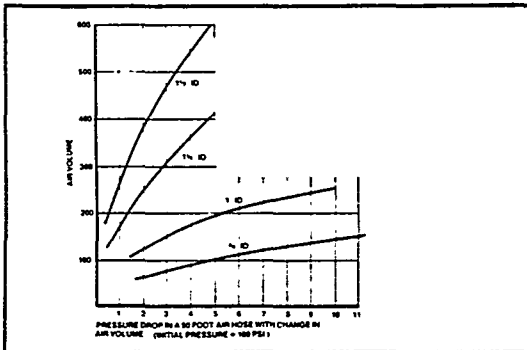
The basic parts of conventional spray equipment are the

- air compressor,
- paint tank,
- hoses for air and fluid, and
- the spray gun.

2. AIR COMPRESSOR MAINTAINS HIGH PRODUCTION RATE

The air compressor supplies the power for the conventional air spray system. Proper output is essential to correctly atomize the paint.

The compressor must supply an adequate amount of both air pressure and air volume to maintain the rate of production required and for the spray gun to operate correctly. The volume is the amount of air produced by the compressor. It is measured in cfm (cubic feet per minute). The air pressure, the force behind the spray painting, is measured in psi (pounds per square inch).



Air volume and pressure are directly related to each other. If the volume of air being compressed drops, the pressure at the gun nozzle will also drop. When the gun is triggered, releasing the air, there must be a great enough supply to replace it or the pressure drops. Instead of a steady stream of atomized paint, the paint is delivered to the surface in small bursts. This pulsing action indicates an insufficient air supply. For best results, an air compressor should be able to exceed the air volume and pressure needed by the spray equipment for a specific job.

In the selection of the air compressor, for conventional equipment, the manufacturer's data sheet will give the suggested pressure for the paint to be used. This information should be compared with the requirements for the air caps and fluid tips to find out the size of the compressor for the job.

The compressed air supply must be free of moisture, oil, and other impurities which could ruin the paint finish. Oil and water can be removed by separators or extractors which are attachments to the compressor.

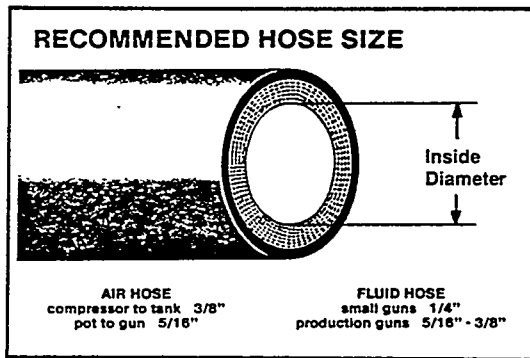
3. THE PAINT TANK HELPS CONTROL PRESSURE

SLIDE OF PAINT TANK

The paint tank holds the material. The air pressure regulator on the paint tank helps to control the pressure at which the equipment will be operated. By providing a constant flow of air into the tank at a uniform pressure, a proper flow of paint to the spray gun is ensured. Some tanks are equipped with agitators for paints that require constant stirring.

SLIDE OF PUMP

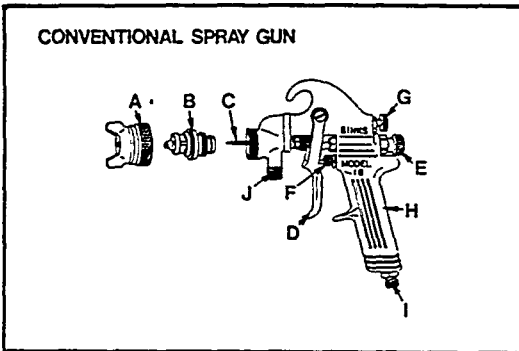
In jobs where heavy materials or large amounts of paint must be applied, a pressure pump can be used in place of a pressure tank. A low pressure pump moves the paint through long hoses and maintains the paint flow to the spray gun. Such a pump, when attached to a 55-gallon drum of paint, allows a painter to spray a large amount of paint without having to stop and refill the supply.



The air hose carries the compressed air and the fluid hose carries the paint material. Both hoses are identified by their "ID," or interior diameter size. The ID is important to know because it determines how much air and paint the hoses can deliver. An air hose which is too small for the job restricts the volume of air causing the pressure to drop in the air line, which will starve the gun. The fluid hose must be able to resist the harshness of the solvents and paint chemicals that flow through it.

To select the proper air hose size, the air volume and pressure requirements must be known. Compressed air does not travel well. Over long distances it tends to lose pressure because friction is created as the air moves against the inner wall of the hose. This friction causes the air movement to slow down and the pressure to drop. The farther the air must travel, the more pressure will drop. Some pressure will always be lost. However, this can be kept to a minimum by using a short hose and avoiding bends in the hose. Ideally, the shortest length hose should always be used. When this is not possible, a larger hose ID can be used. This will help maintain the air hose pressure. Usually the air hose from the compressor to the pressure tank is at least 3/8-inch ID; from the pressure pot to the gun a 5/16-inch ID hose is used.

The fluid hose size is determined by the volume and the pressure of the paint required at the gun. Heavy materials may use large hoses as large as 1/2 - 3/4 inch ID. Small guns often use 1/4 inch ID hoses, while production guns use 5/16 - 3/8 inch ID hoses.

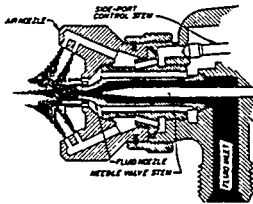


The conventional gun is a complex tool which allows the painter a great deal of control during the spray painting operation. There are ten basic parts to the gun and each one has a specific purpose.

- a. Air nozzle or cap. The air nozzle directs the compressed air into the stream of paint. The air atomizes the paint at this point and directs the flow of particles onto the surface.
- b. Fluid nozzle or tip. The fluid nozzle regulates the amount of paint released and directs the paint into the stream of compressed air.
- c. Fluid needle. The needle starts or shuts off the fluid flow through the fluid nozzle. Select the fluid nozzles and needles in pairs, as they must be of the same size to operate correctly.
- d. Trigger. The trigger operates the air valve and the fluid needle.
- e. Fluid adjustment screw. The fluid adjustment screw controls the fluid needle and adjusts the volume of paint which reaches the fluid tip.
- f. Air valve. The air valve controls the rate of air flow through the gun to the nozzle.
- g. Side port control. The side port control regulates the supply of air to the air nozzle and it determines the size and shape of the spray pattern.
- h. Gun body and handle. The gun body is the part of the equipment the painter holds to operate the spray gun.
- i. Air inlet. The air inlet is at the bottom of the handle and is connected to the air hose.
- j. Fluid inlet. The fluid inlet is an opening below the fluid needle and it connects to the fluid hose.

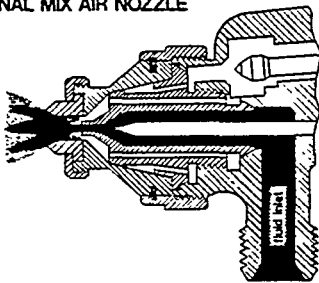
Two general types of air nozzle are available. Select the proper air nozzle according to the type of material to be sprayed and the volume of air available for the spray gun.

EXTERNAL MIX AIR NOZZLE



The external mix air nozzle is widely used. It is called external mix because the paint fluid is atomized outside of the nozzle, in front of the tip, by the action of a jet of air. This kind of nozzle can be used with all paint fluids and for most heavy production work. Its spray pattern can be adjusted and controlled and is not affected by wear or the build-up of dry material.

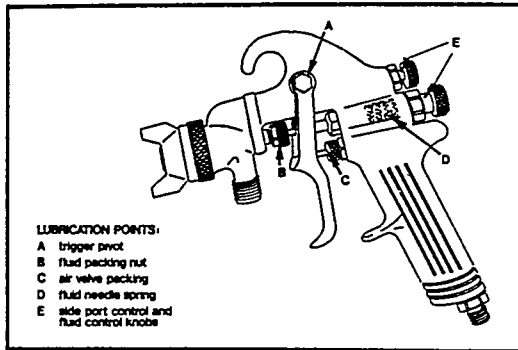
INTERNAL MIX AIR NOZZLE



The internal mix air nozzle atomizes the paint fluid by mixing the air and fluid inside the air nozzle. This kind of nozzle requires a smaller volume of air to operate and it produces less overspray and rebound than the external mix air nozzle. It is usually used in maintenance work and in high production paint applications which do not require a fine finish. The spray pattern size and shape cannot be adjusted with this kind of nozzle.

Catalyzed paints and other fast drying paints tend to clog the openings of internal mix air nozzles and should not be used.

6. REGULAR SPRAY GUN CLEANING AND LUBRICATION REDUCES DOWN-TIME



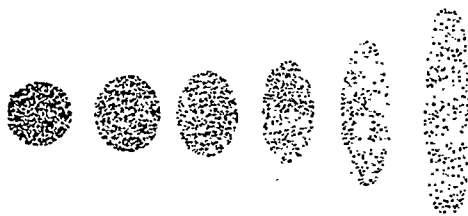
Most spray painting problems a painter experiences are directly related to improper or inadequate cleaning of spray guns. Both conventional and airless spray guns should be thought of as precision tools and they should be cared for as such. They must be kept lubricated and clean.

Follow these rules for keeping an air spray gun in its best working order:

- Never soak the whole gun in solvent. Solvents remove lubricants and dry out the gun packings. Dirt can collect in the air passages and can later mix with the paint and be sprayed onto the surface.
- Lubricate the air spray gun every day with a drop of light machine oil to keep the parts moving easily. The points that need lubrication are the
 - a. trigger pivot,
 - b. fluid packing nut,
 - c. air valve packing,
 - d. fluid needle spring, and
 - e. side port and control knobs.
- Wash the gun body with a rag dipped in solvent. To clean other exterior surfaces, only the front end of the gun is put into solvent. A non-wire brush should be used to remove any paint that has dried on the surface.
- To unclog the air nozzle, remove and wash it separately in clean solvent. A pipe cleaner, a broom bristle, or a match can be used to clean the holes. Wire or other sharp instruments may cause permanent damage to the nozzle and should never be used.
- Never use oils or lubricants containing silicones.

7. HOW TO CORRECT A FAULTY
AIR NOZZLE SPRAY PATTERN

PROPER AIR SPRAY PATTERNS

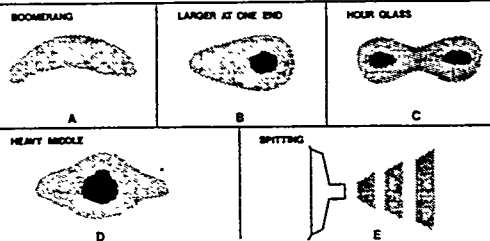


A proper spray pattern may be round or "fan" shaped (a long oval). Generally, proper atomization can be achieved in any pattern. Assuming that the fluid and air pressures remain the same, the amount of paint will remain the same and changes in the size of the pattern will result in different film thicknesses being applied. As the area of the pattern increases, the paint film thickness decreases.

The ideal spray pattern for shipyard production work is a long oval with clearly defined edges. Within the oval the paint particles should all be the same shape and size and be uniformly distributed within the fan. When the trigger is fully depressed, this pattern should be clearly formed with little off-spray and rebound. Keeping spray pressures as low as possible will help in the formation of this ideal pattern.

An experienced painter should be able to observe the spray pattern and know how to adjust the air spray gun to correct faults in pattern shape and paint distribution. Some of the most common spray pattern problems are pictured here. They can usually be corrected by simple procedures.

**FAULTY AIR SPRAY
PATTERN PROBLEMS**



A. "Boomerang" pattern.

Cause: Dried paint in one of the side port holes of the air nozzle. At full pressure the air and paint exit from the clean side port.

Remedy: Dissolve the dried paint with thinner. Do not use metal devices to probe into the air nozzle openings.

B. Larger at one end.

Cause: 1) Dried paint around the outside of the fluid tip, restricting the passage of atomizing air.
2) Loose air nozzle; also bent fluid nozzle or needle tip.

Remedy: 1) Remove air nozzle and wipe off the fluid tip with thinner.
2) Tighten the air nozzle and replace any bent parts.

C. Hour glass pattern.

Cause: 1) Air pressure is too high.
2) Not enough paint; fluid pressure is too low.
3) Too wide a pattern with thin paint.

Remedy: 1) Reduce the air pressure.
2) Increase fluid supply.
3) Adjust pattern control knob.

D. Heavy middle.

Cause: 1) Air pressure too low.
2) Too much fluid fed to the gun.

Remedy: 1) Increase air pressure.
2) Decrease fluid pressure or use a smaller fluid nozzle orifice.

E. Fluid spitting; air entering fluid supply.

Cause: 1) Dried or missing packing around the fluid needle valve.
2) Dirty fluid nozzle seat.
3) Loose fluid nozzle, packing nut, fluid hose.

Remedy: 1) Clean packing with light machine oil. Replace if necessary.
2) Clean fluid nozzle seat area with thinner.
3) Tighten connections and fittings.

8. FIELD DEMONSTRATION OF SET-UP AND SHUT-DOWN PROCEDURE FOR CONVENTIONAL EQUIPMENT

With a pressure tank system, the setting-up procedure is as follows:

1. Attach air hose from compressor tank, or control device such as an air transformer, to air inlet on the pressure tank lid. Connect atomizing air hose and paint hose to the spray gun. Tighten all connections with a hose wrench. Do not use pliers or pipe wrenches.
2. Open the relief valve on the tank. Keep valves to tank and hose closed.
3. Fill tank or removable tank liner with paint.
4. Fasten lid to tank. Tighten clamps.
5. Close relief valve.
6. Start the compressor.
7. Open the valve to the tank but not to the atomizing air hose.
8. Open the air spreader and fluid adjusting valves on the spray gun.

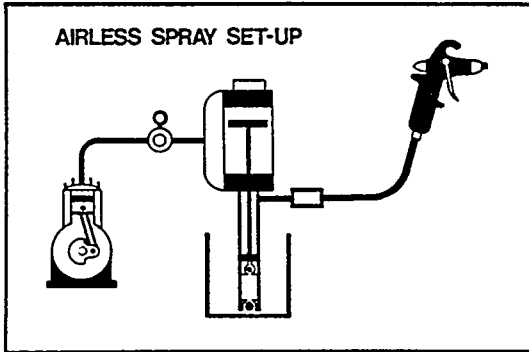
At this point, you must decide what pressures to use for the job. Use the manufacturer's instructions as a guide and determine the pressure settings as follows:

1. Remove the air cap from the gun.
2. Trigger the gun and increase the fluid pressure until a stream of paint shoots out about three feet before it begins to fall into a pail on the floor. Release the trigger.
3. Replace the air cap and set the air pressure somewhat below the recommended setting. Test the spray pattern. Increase the air pressure by five pounds at a time until you obtain the best atomization.
4. Spray a small area of surface. If the paint seems too dry, reduce the air pressure or increase the paint tank pressure until the test spray pattern and finish is just right. Do whichever adjustment will come closest to the manufacturer's specifications.

Follow this checklist for the basic shutting-down procedure, but always read the manufacturer's instructions for the actual equipment being used.

1. Close air inlet valve to the tank. Leave atomizing air to gun turned on.
2. Open relief valve on the pressure tank. This will depressurize the tank.
3. Open the tank lid carefully.
4. Loosen the air cap on the gun about a half turn. Hold a wadded cloth over the cap and trigger the gun. This will force any paint in the gun and hose back to the tank. CAUTION: This operation, called "blow-back," can only be used with conventional air spray. It must never be used with the airless spray painting equipment.
5. Remove paint from the tank. Clean the insert or interior of the tank by pouring a small amount of solvent into the container.
6. Pour enough solvent into the tank to also wash the interior of the spray gun and hose.
7. Trigger the gun and allow the solvent to run through the gun until the solvent comes out free of paint particles. Repeat the blow-back procedure.

9. THE BASIC AIRLESS SPRAY SET-UP HAS ONLY
THREE MAJOR PARTS

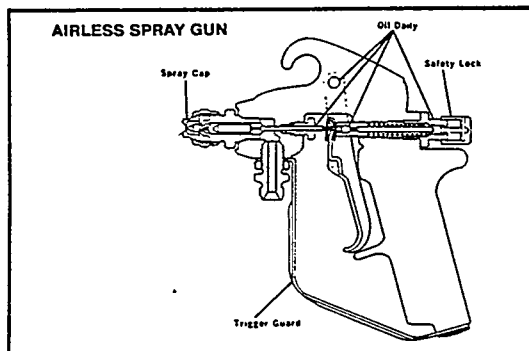


The basic parts of airless spray equipment are the

- high pressure paint pump,
- paint hose, and
- airless spray gun.

The high pressure pump draws the paint from the container and forces it through the paint hose and spray gun. Pumps for airless spray painting are identified by the ratio of paint pressure produced to that of the air pressure used to drive them. If a pump delivers paint at a pressure of 30 psi for each 1 psi of air pressure delivered by the air compressor, this pump has a 30:1 ratio.

The paint hose must be able to stand very high pressure as it carries the paint from the pump to the gun. Most operations will require only 1800 psi to 3500 psi, but most airless hoses can handle pressures up to 5000 psi. The hoses range in size to accommodate paints which have different viscosities. For medium viscosity paints, use a hose between 1/8 - 1/4 inch ID and for heavier paints use a hose from 3/8 - 1/2 inch ID.



The spray gun is basically a fluid nozzle and a valve -- a passageway for the paint fluid. There is a spray tip filter which screens out particles of paint that could clog the tip. Tip screens come in various sizes and should be selected in relationship to tip size. A screen which is too coarse will allow an airless tip to clog. Each spray tip is designed to give a specific spray pattern and flow. There is only one hose -- the high pressure paint hose -- connected to the gun.

10. AIRLESS SPRAY PATTERN IS CONTROLLED
BY TIP SELECTION

There is only one way to control the spray pattern from an airless gun: choose the right tip. The size of the orifice (.007 - .072 inches) controls the amount of fluid delivered and the atomization. The tip angle (10 to 80 degrees) controls the fan width. Two tips having the same orifice size but different angles will spray the same amount of paint per minute, but the paint thickness and fan widths will be different.

Each airless tip has one spray pattern. Every time a different pattern is needed the tip must be changed. The type of pattern used depends on the type of work being done. Wide spray patterns are used for high production work on large surfaces. Narrower patterns are for closer and finer spray painting work.

In shipyard production work, choose a tip by determining the largest pattern and smallest orifice practical for the paint viscosity and the rate of application desired for the job. While airless spraying does not involve air delivered at the gun the air supply is still important. An adequate volume and pressure of air must be available to deliver a continuous stream of paint. Allowances must be made for additional air operated accessories such as agitators.

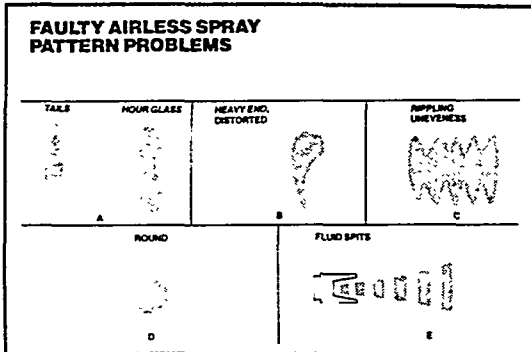
SLIDE OF CHART

The following chart indicates some typical tip sizes and psi requirements for commonly used marine paints:

TYPICAL AIRLESS TIP SELECTION

<u>PAINT TYPE</u>	<u>ORIFICE SIZE</u>	<u>PRESSURE</u>
Acrylic, modified	.013" tip	2200 psi
Chlorinated rubber	.013	2200
Epoxy, polyamide	.015	2000
Vinyl, copolymer	.015 - .017	2000
Epoxy, amine	.017 - .021	2200
Phenolic, modified	.019 - .025	2200
Antifouling	.021	2000
Inorganic zinc	.023 - .029	900 - 1800
Inorganic zinc	.026 - .031	900 - 1800
Coal tar epoxy	.031	2400

A faulty spray pattern is an indication that the tip, filter or atomization pressure needs adjustment. A good airless spray pattern -- like a good air spray pattern -- should have a smooth oval outline, clearly defined edges, and an even distribution of paint particles throughout. The way in which the pattern is misshapen will give an experienced painter clues as to the cause of the problem.



Some common airless spray patterns are shown here. Knowledge of airless equipment is essential to remedy the problems.

A. Tails or hour glass shape.

Cause: Inadequate fluid delivery or improper fluid atomization.

Remedy: Increase fluid pressure; decrease fluid viscosity; choose larger tip orifice; clean the gun and filters; or reduce number of guns using one pump.

B. Heavy at one end, distorted.

Cause: Clogged or worn nozzle tip.

Remedy: Clean the nozzle tip; replace if necessary.

C. Rippling, uneven pattern.

Cause: Pulsating fluid delivery or suction leak.

Remedy: Increase supply to air motor; reduce number of guns using one pump; choose smaller tip orifice; clean tip screen and filter; or look for hose leak.

D. Round pattern.

Cause: Worn nozzle tip or fluid too heavy for tip size.

Remedy: Replace worn tip; decrease fluid viscosity; increase pressure; or choose correct nozzle tip.

E. Fluid spitting.

Cause: Air entering system; dirty gun; or wrong cartridge adjustment.

Remedy: Look for hose leak; clean the gun; or adjust cartridge and replace if necessary.

With an airless spray gun, the most common operating problems are due to the tip getting clogged. Clean the fluid hose well, as the most common cause of clogging is dried paint flaking off the inner walls of a used paint hose. All airless equipment should be flushed with solvent after each use.

To clean the airless tip, follow this procedure:

- first relieve fluid pressure;
- rotate trigger release to safe position;
- remove cap, nozzle tip, and gasket;
- flush nozzle tip with solvent; and
- blow air through tip and look for blockage.

To make cleaning easier, some tips have a reverse flush attachment, which instantly relieves the clogged paint. Remember NEVER to pull the trigger with a finger in front of the tip.

12. FIELD DEMONSTRATION OF SET-UP AND SHUT-DOWN
PROCEDURE FOR AIRLESS EQUIPMENT

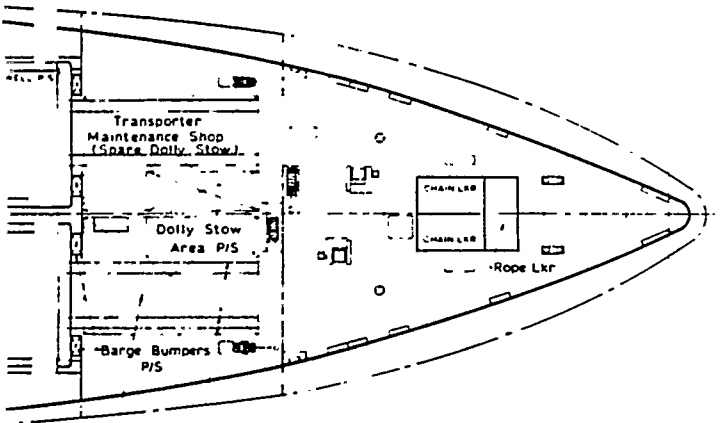
The basic procedure for airless equipment set-up is as follows. Read the manufacturer's instructions for specifics regarding the type of equipment in use.

1. Connect air supply hose between air inlet on the pump and the air supply.
2. Connect the high pressure fluid hose between filter manifold (or pump outlet) and the spray gun.
3. Make certain that the regulator adjustment is backed off, then open the main air supply valve to the regulator.
4. Immerse fluid pump or siphon hose in container or suitable solvent.
5. Turn air regulator adjustment until pump begins to operate slowly.
6. Direct spray gun into solvent container and pull trigger.
7. Increase air regulator and run pump for approximately 30 seconds at a moderate speed. Back-off regulator until pump stops.
8. Check all hose connections for leaks.
9. Remove siphon hose or fluid pump from solvent.
10. Open regulator and allow system to pump out solvent.
11. Allow air to flow through system for about 30 seconds.
12. Check agitator and other air operated accessories for proper functioning.
13. Shut off air inlet.
14. Strain paint and other similar fluids before filling reservoir.
15. Fill the fluid reservoir.

16. Immerse siphon hose or pump in fluid.
 17. Select proper tip.
-

After use, these procedures should be followed for shutting down the airless spray equipment.

1. Shut off air to pump by closing the air supply valve.
2. Decrease air pressure regulator.
3. Release fluid pressure by placing gun below material in the fluid reservoir and pulling trigger until fluid ceases to flow or by opening by-pass valve if so equipped.
4. Remove pump or siphon hose from fluid container.
5. Remove nozzle tip from gun and place in solvent.
6. Insert pump foot valve or siphon hose in container of suitable solvent.
7. Open air valve.
8. Increase pressure regulator until fluid pours slowly from gun. Direct flow into fluid container.
9. When solvent flows from the gun, direct the stream into the solvent container.
10. Allow the solvent to circulate several minutes, then change to clean solvent. Do not let dirty solvent circulate.
11. Circulate once more, triggering the gun periodically to change the pressure in the pump. Continue until system is clean.
12. Never back flush an airless gun. It can be a deadly way to clean an airless spray gun.



PART C

QUIZ

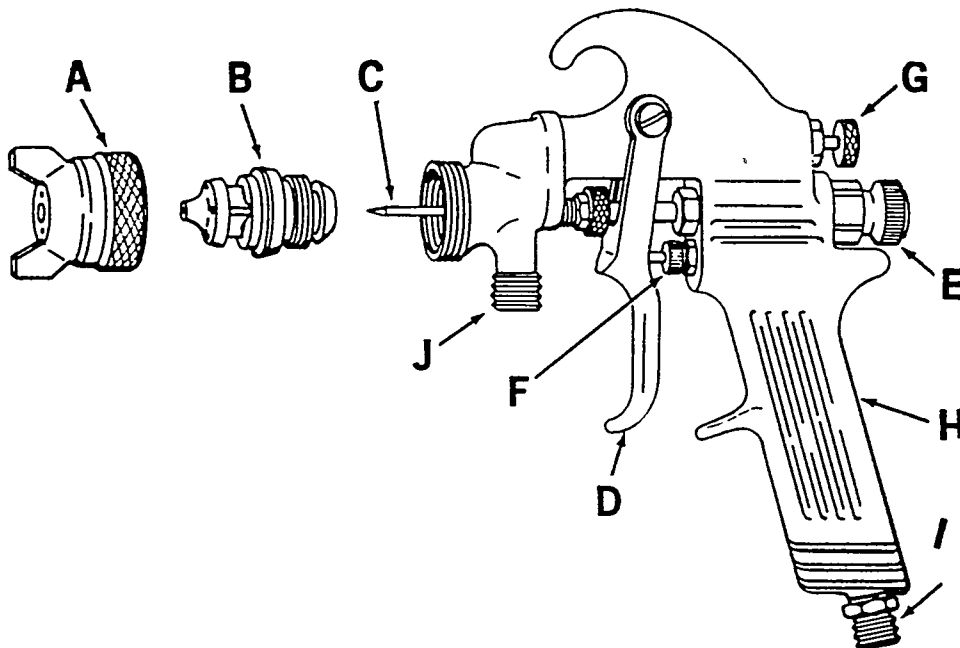
UNIT III

SET UP AND EFFICIENT OPERATION OF SPRAY EQUIPMENT

N ME: _____ DATE: _____ INSTRUCTOR: _____ GRADE: _____

The ten parts of a conventional spray gun are named below. Match them with the diagram by placing the correct letter next to the name of each part.

- | | |
|-----------------------|---------------------------------|
| 1. _____ air cap | 6. _____ fluid inlet |
| 2. _____ air valve | 7. _____ fluid adjustment screw |
| 3. _____ air inlet | 8. _____ trigger |
| 4. _____ fluid tip | 9. _____ side port control |
| 5. _____ fluid needle | 10. _____ gun body & handle |



Circle the most correct answer.

11. Air pressure loss in a conventional gun can be minimized by all but one of the following:

- A. keeping the air hose short
- B. keeping the air hose straight
- C. using a larger ID air hose
- D. selecting quality hose that resists attack by paint chemicals

12. Which is NOT a reason that airless tips clog?

- A. tip screen is too coarse
- B. tip angle incorrect for paint being sprayed
- C. no screen used
- D. tip screen punctured

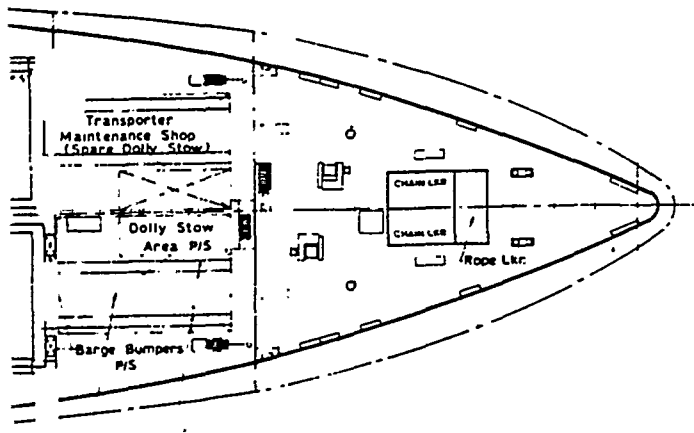
13. Is the size and length of the air inlet hose important in airless spraying?

- A. No. Airless spraying means no air requirements.
- B. No. Pump ratio is all that matters.
- C. Yes. Narrow hose improves performance.
- D. Yes. Inadequate hose size can cause pulsing.

Check the correct answer.

	<u>TRUE</u>	<u>FALSE</u>
14. When oil or dirt ruin a paint film applied with a conventional gun over a properly cleaned surface, the problem might be in the compressed air supply.	[]	[]
15. A pressure drop after each triggering of an airfed gun may indicate an insufficient volume of air.	[]	[]
16. The size of air caps and fluid tips depend on the viscosity of the paint and are not related to compressor size.	[]	[]
17. A pressure pump attached to the paint drum is more efficient than a paint tank for moving low viscosity materials.	[]	[]
18. Air hose from the compressor to the paint tank is usually 3/8 inch ID or larger.	[]	[]
19. Air and fluid hoses to the gun are usually 5/16 inch ID or larger.	[]	[]
20. External mix nozzles are not affected by dry material build-up.	[]	[]
21. Internal mix nozzles require a smaller volume of air and create less rebound.	[]	[]
22. Spray pattern size and shape can be controlled by the operator using an internal mix nozzle.	[]	[]
23. Spray guns are precision tools which require proper maintenance.	[]	[]
24. For fast thorough cleaning of a spray gun, soak it in a can of solvents overnight.	[]	[]
25. The air nozzle may be washed in solvent but it is more efficient to ream out the dried paint with a wire or pointed instrument.	[]	[]

	<u>TRUE</u>	<u>FALSE</u>
26. A heavy build-up in the center of an air spray pattern indicates low air pressure.	[]	[]
27. Dried paint in an air nozzle's side port hole gives a spray pattern the shape of a crescent.	[]	[]
28. A typical high pressure paint hose for airless spray can handle pressures of 5000 psi.	[]	[]
29. A high viscosity paint requires a larger fluid hose.	[]	[]
30. If a tip screen is used in an airless gun there is no need to strain the paint.	[]	[]
31. High velocity causes paint to atomize in an airless gun. High velocity is caused by high pressure and a relatively small orifice.	[]	[]



PART C

PLANNING NOTES

UNIT IV GOOD SPRAYING PRACTICES

Learning Objectives

After classroom discussion and field evaluation of proper paint application techniques, the trainees should have the ability to:

1. Explain the importance of stroking speed, distance, overlapping, and triggering for laying on a good coat of paint.
2. Demonstrate the correct method for spraying flat work, long work, and inside and outside corners.
3. Identify several possible causes for defects observed in the coating film. Explain the proper way to prevent these defects by correcting operator technique or adjusting the equipment.

Notes to the Instructor

A field demonstration should be organized to enable each painter to practice using conventional and airless equipment. This demonstration may be held immediately following the classroom work or at the next scheduled lesson. Divide the group into teams of two. Allow five minutes for each person on each gun. Have one team member "supervise" the other's technique, then reverse roles. Evaluate the following skills:

a. SPRAY GUN ADJUSTMENT

- fluid pressure
- air pressure (conventional only)
- atomization
- spray pattern

b. SPRAY TECHNIQUES

- gun distance
- triggering technique
- perpendicularity
- overlapping
- bounce-back/fogging

c. COATING FILM

- uniform thickness
- free of sags, wrinkles, cracks, dry spray, fish eyes
- edges and corners evenly coated

After the initial supervised practice and evaluation, on-the-job-training (OJT) time will be needed to develop painting skills. The guidelines above can be developed into a test for rating level 1, 2, & 3 painters.

Equipment/Aids

Slide projector and screen, etc.

The field exercise will require careful planning. Be certain that the equipment is in working order before the trainees arrive and that there is sufficient paintable surface to work on. Provide flat areas, as well as shapes, I-beams, corners, edges and pipe sections.

Unit Quiz

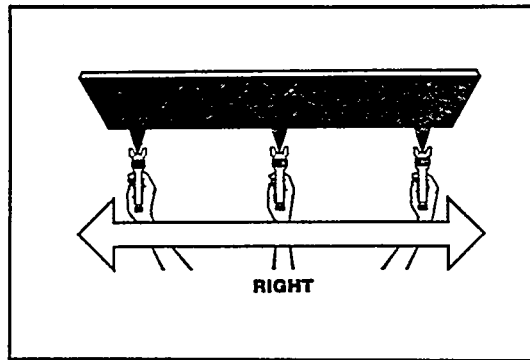
A 10-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz C-IV:

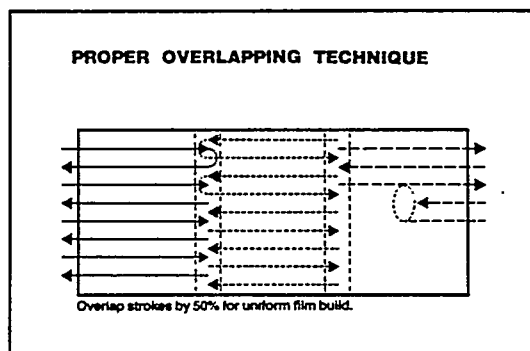
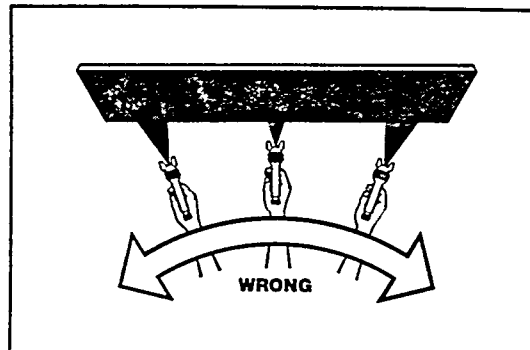
- | | | |
|----------|-------|-------|
| 1. C | 6. T | 11. T |
| 2. D | 7. T | 12. F |
| 3. A & D | 8. F | 13. T |
| 4. A & C | 9. F | |
| 5. D | 10. T | |

GOOD SPRAYING PRACTICES

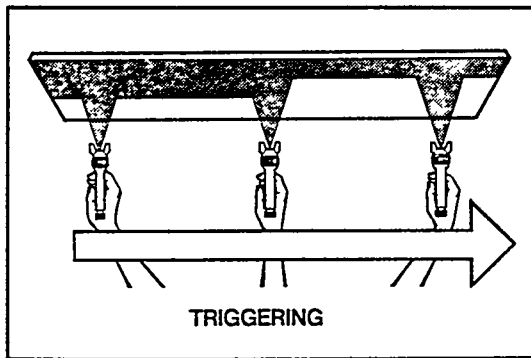
Proper stroking technique is essential to good spray painting. Poor techniques can waste material, make the painter's work more difficult and produce an inferior paint job. Generally, the same techniques are used with conventional and airless spraying. The following rules are basics and should be used in both methods of spray painting.



Stroking. While holding the spray gun at a right angle to the work, move the arm and shoulder as well as the wrist parallel to the surface. This prevents "arcing" which gives an uneven coat. The arm must remain at right angles to the surface.



Each stroke should overlap the previous stroke by 50%. If uniform overlapping is maintained, the film thickness will be uniform.

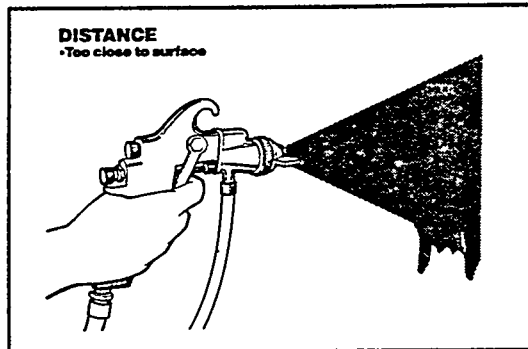


Triggering. The spray gun should be triggered at the beginning and end of each stroke. The gun should be in motion before triggering and before releasing at the end of a stroke. This method helps to give accurate control of the spray gun and the materials.

Triggering also functions to

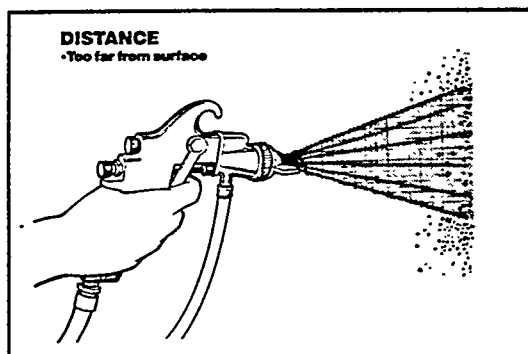
- keep the fluid nozzle or airless tip clean;
- reduce paint loss;
- prevent heavy build-up of paint on corners and edges;
- eliminate the build-up of fluid on the nozzle and tip which could cause the gun to give off a heavy deposit on the work; and
- prevent runs and sags at the beginning and end of each stroke.

Speed. Spraying should always be done at a consistent rate of speed. The proper speed deposits a full, wet coat with each stroke. A slow stroke deposits a thick film and a faster stroke applies a thinner paint film. If quick stroking is needed to avoid flooding, then the fluid nozzle is too large or the fluid pressure is too high. If slow stroking is necessary to get a wet coat, increase the fluid pressure or the size of the fluid nozzle. Speed and rhythm are developed with experience.



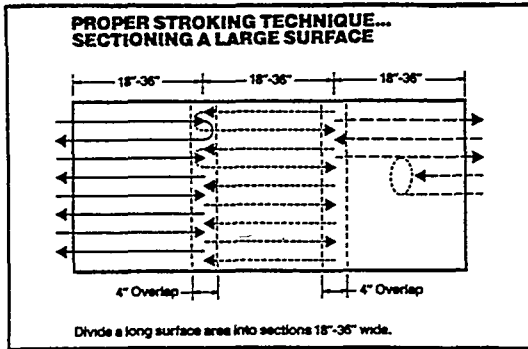
Distance. The material and atomization pressure determine the proper distance from the surface. It may vary from 6 to 12 inches for conventional spraying and 12 to 15 inches for airless, which gives a wetter spray. The paint should always go on evenly and wet.

If the spray gun is held too close to the surface, the paint will go on too heavy and tend to sag.



If the gun is too far away from the surface, there is excessive spray dust which gives a sandy finish.

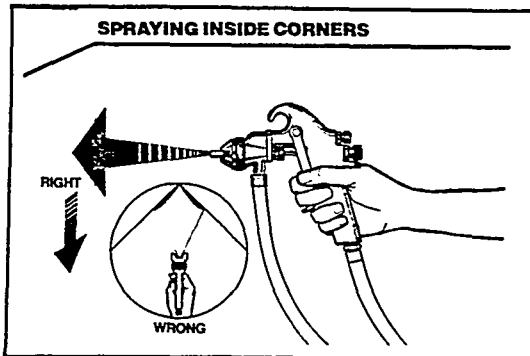
2. LARGE SURFACES REQUIRE SECTIONING AND OVERLAPPING



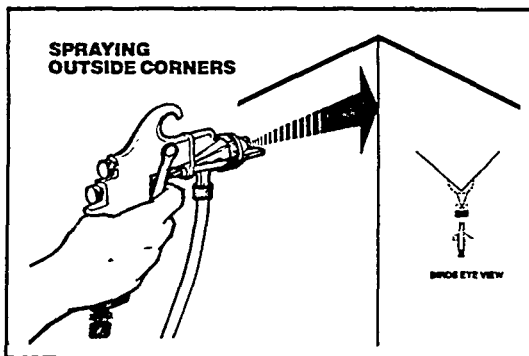
An ideal stroke length is 18 to 36 inches. When a surface area is too long to be sprayed with one stroke, it is divided into separate sections. The basic triggering and horizontal stroking technique is used on each section. Each area slightly overlaps the previous one to give an even and continuous film.

3. SPECIAL TECHNIQUES FOR INSIDE AND OUTSIDE CORNERS

To get an even film build on inside and outside corners, special application techniques are required for the two kinds of corners.

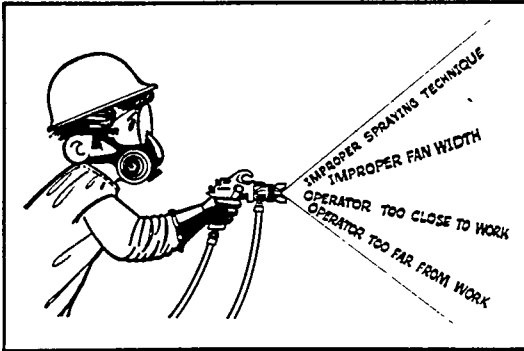


Each side of an inside corner should be sprayed separately. If the spray gun is aimed directly into the corner, the coating will not be uniform. It will go on too thin in the corner and too heavy at the sides. To get an even coating, a vertical stroke is used at one side, followed by a short horizontal stroke applied in the direction away from the corner.



When spraying an outside corner, the gun is aimed directly at the corner. One stroke coats the corner and the adjoining sides at the same time. Each side is then sprayed separately.

4. PROPER TECHNIQUE REDUCES FILM DEFECTS



Many film defects are caused by improper spray application technique. The operator can control the appearance of these defects at the time of application.

The following are some common problems which the operator can control, by adjusting technique.

Improper Spraying Technique (stiff wrist, swinging arm; tilting gun)

- spray pattern on surface will vary from narrow to wide (like an hour glass) with each spray stroke
- possible variation of sheen due to overspray on work just completed
- uneven film thickness affecting the film durability

Improper Fan Width

- inadequate film build in the angle vertex or fillet of "I" and "H" beams when a painter uses a wide fan and sprays at a 45° angle from the flange into the corner. An excessive film build on the web and flange may also occur
- inadequate film build on bar joists when too wide fan is used

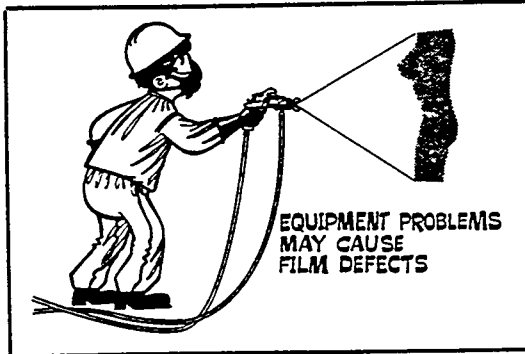
Spray Operator Too Close to His Work

- excessive film build
- runs, curtains, sags
- poor film adhesion due to improper drying and curing
- high film build; wrinkles while drying and may hold contaminants
- excessive paint used
- orange peel pattern and blow holes

Spray Operator Too Far Back from His Work

- film build too thin
- uneven film build
- dry spray: the film is permeable
- uneven angular sheen due to overspray on finished work
- overspray deposits on unprotected substrate
- excessive paint used

5. EQUIPMENT PROBLEMS MAY CAUSE FILM DEFECTS



The operator should be very familiar with his/her equipment so he/she can avoid film defects caused by difficulties with the equipment. Following are some common equipment difficulties and the problems that may result.

Worn or damaged spray tips. Damaged or worn tips are the most common problem in airless spraying. They can be detected by a lopsided or distorted spray pattern. Strings or fingers of unatomized paint particles may also be observed as well as

- uneven film thickness;
- runs and sags in paint film; and
- permeable film.

Atomization pressure too high. Excessive pressure may result in sags, runs, wrinkles, alligating and other defects associated with too thick a coating. These are particularly noticeable around irregular shapes that require more than one spray pass.

Partially clogged high pressure fluid strainers. A large drop in pressure at the gun when the trigger is pulled will be observed. This results in poor atomization.

Spray equipment undersized for the job.

- Lower production rate could promote the appearance of laps when using fast drying coatings.
- If the spray tip is too large for the machine, then a coarse, inadequately atomized coating will be applied which will leave a permeable film.
- The spray operator may spray to cover rather than spray to a specified film thickness to reduce the application time. The end result is a film that is too thin.

Paint hoses too long or too small in diameter.

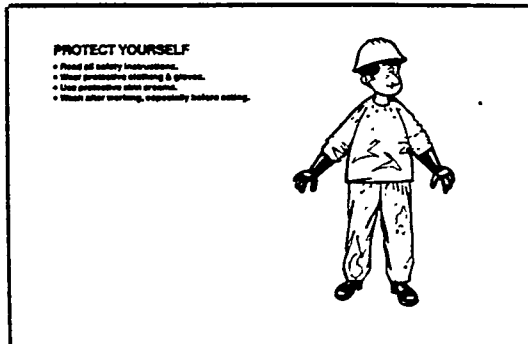
- A coarse inadequately atomized coating will leave a pebbly appearance.
- The film will have thin spots affecting durability.

Air supply hoses too small or too long.

- The paint pump cannot maintain constant pressure.
- The spray pattern will show inadequate atomization in the form of a coarse and pebbly texture and strings and fingers coming from the spray gun.
- Pulsation of the spray pattern, changing size of the atomized paint particles, and fluctuation of the spray fan width delivers an uneven film thickness, and may affect film durability.

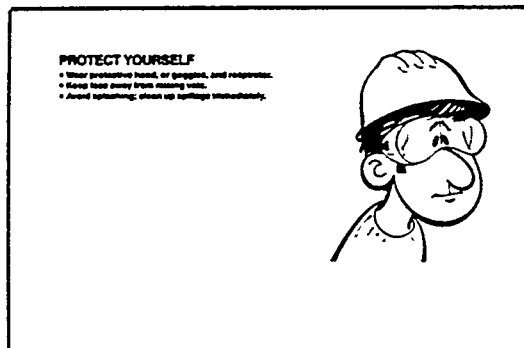
UNIT V
SAFETY AND HEALTH MEASURES
IN PAINT APPLICATION

1. PROTECTING YOURSELF
FROM TOXIC PAINT MATERIALS



The health hazards primarily associated with the application of coating materials are skin irritations due to direct contact with harsh materials or poisonous effects from breathing toxic solvent vapors. A painter can protect himself/herself from these potential health hazards by following these rules.

- Read the manufacturer's data sheet for safety instructions related to the coating material.
- Wear protective clothing and gloves.
- Apply protective creams to any exposed parts of the body.
- Wash immediately after working, and especially before eating or smoking. The application of cold cream or another lanolin ointment can prevent the skin from drying out.



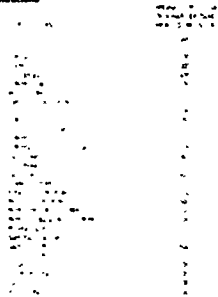
- Use a protective hood or goggles and a respirator.
- Keep face away from mixing vats and avoid breathing vapors.
- Use low speed mechanical mixers and avoid splashing. Clean up spillage immediately.

Some solvents which are used in protective coatings (e.g., ketones, toluene, xylene) may cause skin irritations because they can dehydrate and remove natural oils from the skin. The dehydration, or loss of water, makes the skin sensitive to more serious irritations when it comes into contact with certain components of the coating material. For example, the amine catalysts, which are used in the two-package epoxies, may burn and cause dermatitis when in direct contact with the skin for even a short period of time. Different people have different reactions to these substances. There are many cases of painters working with amine-cure epoxies for years with no ill effects. Others may develop a rash after just a few cases.

The high vapor concentrations of the amines may also be irritating to the eyes and mucous membranes of the mouth and nose. Serious lung damage has been reported. However, these conditions do not affect the entire body. They remain local and are similar to allergic reactions.

Overexposure to certain solvents can produce serious sickness. This may include headaches, nausea, choking sensations, disturbed heart action, or injury to liver, kidneys, or heart.

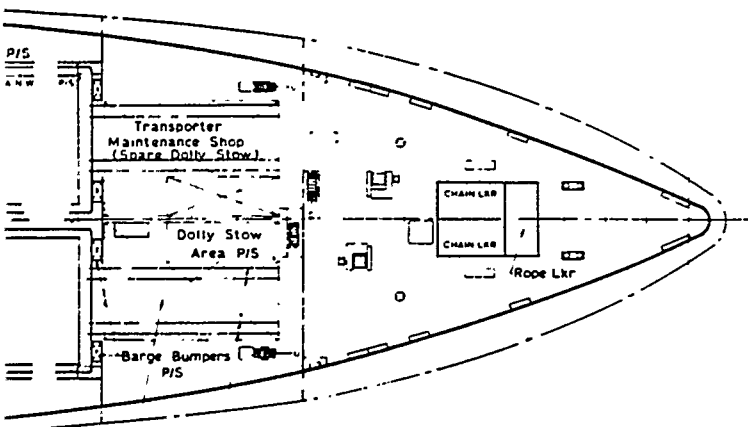
Maximum Allowable Concentration
of Solvent Vapors
(MAC)



There is a maximum allowable concentration (MAC) of solvents present in the air that may be inhaled without danger in an eight-hour working day. The concentrations at which repeated exposure will have no ill effect on nearly all workers is known as the Threshold Limit Value (TLV). It is measured in terms of parts-per-million (ppm) by volume in air. Referring to the chart, mineral spirits and naphtha have a low level of toxicity compared to xylene and toluene which can only be breathed safely at much lower concentrations. Because of the wide variation in individual reactions, threshold limits should be used as a guide to control possible solvent vapor hazards. Individual workers must still observe all safety precautions including the use of respirators.

Work only in areas where ventilation is supplied in quantities sufficient to remove hazardous concentrations of vapors. This is especially important in confined work areas, such as cargo tanks.

If the skin does come into contact with irritating materials, wash with soap and water soon after. DO NOT wash with solvent. The solvent will penetrate the skin, carrying the toxic material with it.



PART C

QUIZ

UNIT IV GOOD SPRAYING PRACTICES

AME:

DATE:

INSTRUCTOR:

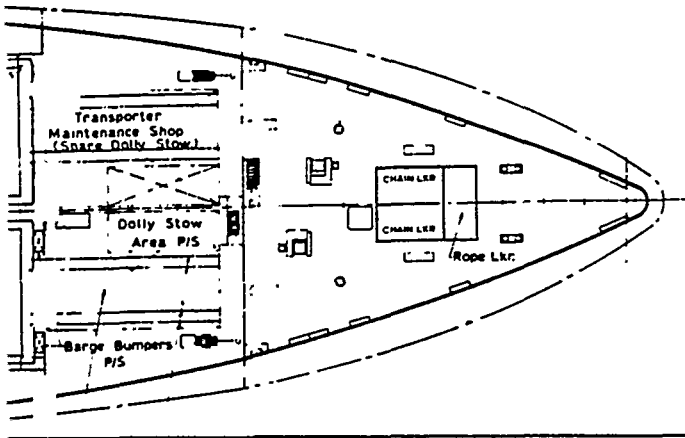
GRADE:

Circle the most correct answer.

1. You pull the trigger on an airless gun to check the fan pattern and find it is lopsided. You would
 - A. Check the couplings on the air lines.
 - B. Ignore the pattern and go on spraying.
 - C. Check the tip for wear and possible need for replacement.
 - D. Bang the tip into shape with a hammer.
2. The applied film has a coarse pebbly appearance. Strings of paint are coming from the gun. This indicates inadequate atomization which might be caused by
 - A. air supply hoses which are too long or too narrow.
 - B. paint hoses which are too long or too narrow.
 - C. too large a spray tip.
 - D. A, B & C
3. Triggering the gun (Choose 2)
 - A. prevents runs at the end of each stroke.
 - B. increases paint loss.
 - C. is a nuisance which should be eliminated.
 - D. improves control.
4. Sags, runs, and alligating are associated with (Choose 2)
 - A. too heavy film build.
 - B. undersized equipment.
 - C. operator too close to his work.
 - D. operator too far from his work.
5. The operator is far back from his work and swinging his arm over long sections. You can expect ALL but one of the following
 - A. uneven film thickness.
 - B. overspray deposits.
 - C. waste of paint.
 - D. runs and sags.

Check the correct answer.

	<u>TRUE</u>	<u>FALSE</u>
6. The gun should be aimed directly at the corner of an outside corner.	[]	[]
7. To obtain uniform thickness, inside corners are best painted with a combination of horizontal and vertical strokes.	[]	[]
8. Fifty percent overlapping of each stroke results in too high a film build.	[]	[]
9. Speed is only important when using an airless spray gun.	[]	[]
10. The spray gun should be in motion before triggering at the beginning of a stroke.	[]	[]
11. To deliver a smooth wet film the operator will usually stand further from his work when using an airless gun.	[]	[]
12. A light dry film may be the result of a too slow stroking speed.	[]	[]
13. If you are arcing the gun, you are painting with a too stiff wrist.	[]	[]



PART C

PLANNING NOTES

UNIT V

SAFETY AND HEALTH MEASURES IN PAINT SPRAY APPLICATION

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Explain how to protect themselves from toxic paint materials.
2. Demonstrate the safe use of spray equipment.
3. Discuss how fire and explosions can occur when handling paint materials.
Review how to prevent them.
4. Review the following key terms:
 - dehydration
 - flammability
 - dermatitis
 - toxic

Equipment/Aids

Slide projector and screen, etc.
Protective clothing, including respirators and protective cream
Airless spray nozzle cap

Reference

IBPAT/OSHA Occupational Safety and Health Training Project. Free program catalog available from: IBPAT, United Unions Building, 1750 New York Avenue, N.W., Washington, D.C. 20006; Tel. 202/872-1540.

Discussions/Group Work

- Topic 1. Demonstrate the proper use of protective clothing, respirators, and protective creams.
- Topic 2. Explain how to use a nozzle guard on an airless spray gun and its value as a safety measure.

Unit Quiz

A 10-minute quiz is provided with this unit. Duplicate copies for each participant. Discuss each question and answer thoroughly.

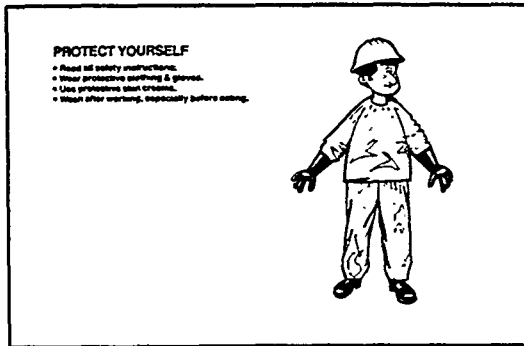
(continued)

Answers to Unit Quiz C-V:

- | | | |
|---------|-------|-------|
| 1. A, C | 6. A | 11. T |
| 2. B | 7. F | 12. T |
| 3. C | 8. T | 13. F |
| 4. D | 9. T | 14. F |
| 5. B | 10. F | 15. F |
| | | 16. T |

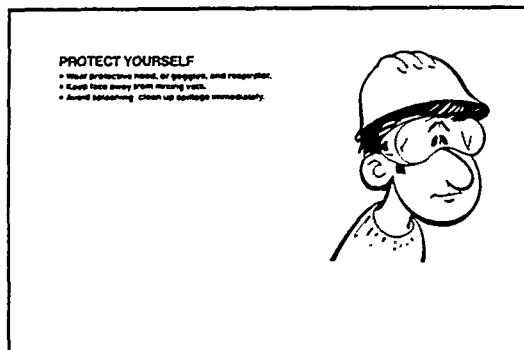
UNIT V
SAFETY AND HEALTH MEASURES
IN PAINT APPLICATION

1. PROTECTING YOURSELF
FROM TOXIC PAINT MATERIALS



The health hazards primarily associated with the application of coating materials are skin irritations due to direct contact with harsh materials or poisonous effects from breathing toxic solvent vapors. A painter can protect himself from these potential health hazards by following these rules.

- Read the manufacturer's data sheet for safety instructions related to the coating material.
- Wear protective clothing and gloves.
- Apply protective creams to any exposed parts of the body.
- Wash immediately after working, and especially before eating or smoking. The application of cold cream or another lanolin ointment can prevent the skin from drying out.



- Use a protective hood or goggles and a respirator.
- Keep face away from mixing vats and avoid breathing vapors.
- Use low speed mechanical mixers and avoid splashing. Clean up spillage immediately.

Some solvents which are used in protective coatings (e.g., ketones, toluene, xylene) may cause skin irritations because they can dehydrate and remove natural oils from the skin. The dehydration, or loss of water, makes the skin sensitive to more serious irritations when it comes into contact with certain components of the coating material. For example, the amine catalysts, which are used in the two-package epoxies, may burn and cause dermatitis when in direct contact with the skin for even a short period of time. Different people have different reactions to these substances. There are many cases of painters working with amine-cure epoxies for years with no ill effects. Others may develop a rash after just a few cases.

Overexposure to certain solvents can produce serious sickness. This may include headaches, nausea, choking sensations, disturbed heart action, or injury to liver, kidneys, or heart.

[illegible]

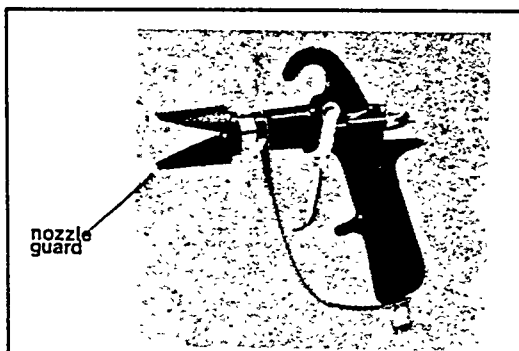
Work only in areas where ventilation is supplied in quantities sufficient to remove hazardous concentrations of vapors. This is especially important in confined work areas, such as cargo tanks.

C.46

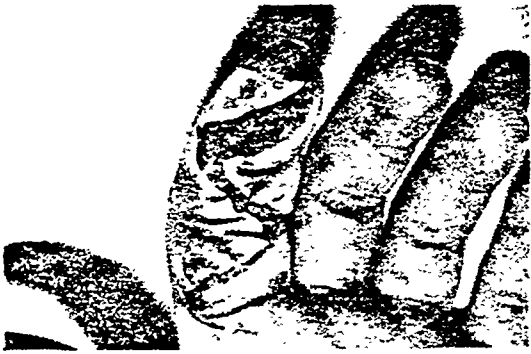
2. AVOIDING MECHANICAL HAZARDS ASSOCIATED WITH THE USE OF SPRAY EQUIPMENT

Mechanical hazards associated with spray equipment may be caused by improper handling or by unsafe equipment. All spray pots, both conventional and airless, should carry a label certifying that they have been constructed according to standards set by the industry (ASME Code for Unfired Pressure Vessels). The safety release valves should be tested on pressure equipment regularly, as should all hose connections and fittings to be certain that they are tight and not leaking. Hoses must also be checked periodically for kinks or abrasion that may develop into a dangerous rupture. Carefully handle all hose connections, joints, and seating surfaces on the spray gun to prevent damage to their surfaces.

The spray gun should not be disconnected from the fluid hose, nor the hose from the pump until the pressure has been released from the hose. Remember that the fluid is under very high pressure. Release the pressure after every day's operation. Never change the nozzle without first shutting off the pump and releasing the fluid pressure.



Using airless spray equipment, with its extreme high pressure, requires special precaution. The jet of material released from an airless spray gun can pierce the skin at close range to the spray cap. Special nozzle guards are provided to keep a greater distance between the operator and the nozzle orifice. These are effective because pressure drops very quickly with distance from the nozzle.



The airless spray gun should never be pointed at any part of the body. Serious injuries can occur if painters place their fingers over the spray tip to clear obstructions. The toxic paint material is injected under the skin and into the bloodstream under extremely high pressure (3000 psi). Medical literature is filled with cases of painters losing a finger, hand or arm by attempting to back flush an airless gun by placing the thumb over the nozzle and releasing the trigger. This works well for conventional spray guns, but can be deadly when tried with the newer airless equipment.

3. REDUCING DANGER FROM FIRE AND EXPLOSION

TYPE OF SOLVENT	HEAVY		EXPLOSIVE LIMITS	
	FLASH POINT, DEGREES F		BY VOLUME % AIR	BY WEIGHT
Acetone	-4	9	2.5	8
Alcohol, butyl	15	5	3.2	
Alcohol, ethyl	50	2.2	3.2	
Alcohol, isopropyl	69	5	3	
Benzene - toluene	1	1	3.2	
Carbon tetrachloride	None	None	Unlimited	
Chloroform	-75	8	6.2	
Dichloroacetic acid	130	7	1	
Dichloromethane	-19	1	1	
Dimethylamine	5	8	3	
Dimethylamine	-78	1	1	
Dimethylsilane				
Ethylmethylacrylate	35	1.8	25.1	
Ethyl ethyl butene HCl	35	1.8	11.2	
Ethyl isobutyl butene HCl			9.2	
Isopropyl acetate	-25 to 12	2	6.5	
Isopropyl alcohol	-60 to 60	0.8	8.6	
Isopropyl alcohol	55	1	9.7	
Isopropyl alcohol-water	None	None	Unlimited	
Isopropyl acetate	95-120	2.8	None	
Isopropyl acetate	90	1.2	5.3	

In the application of paints and coatings, there is potential danger from fire and explosion.

A paint's ability to burn, its flammability, is determined by the temperature it can reach before it will catch on fire when a flame is applied. This is called the "flash point." Special care should be taken to avoid storing or using a paint in an area with a temperature that is near or above the flash point. Paints which contain the stronger solvents, such as xylene and toluene, have lower flash points and are very flammable. The higher the flash point, the lower the flammability.

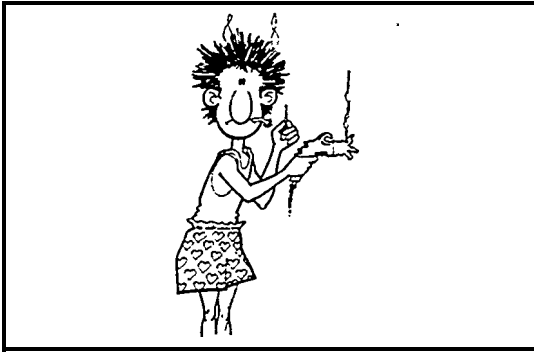
The likelihood of an explosion with a solvent is dependent upon the concentration of the solvent vapors in the surrounding atmosphere. Three things are required for an explosion to occur: a spark, oxygen (air), and fuel (which is the solvent vapor). There must be the right proportion of fuel and oxygen when the spark is introduced to cause an explosion. The percentage by volume of solvent vapor which will support an explosion varies for different solvents. Refer to the chart for the explosive limit range of commonly used paint solvents.

GROUNDING

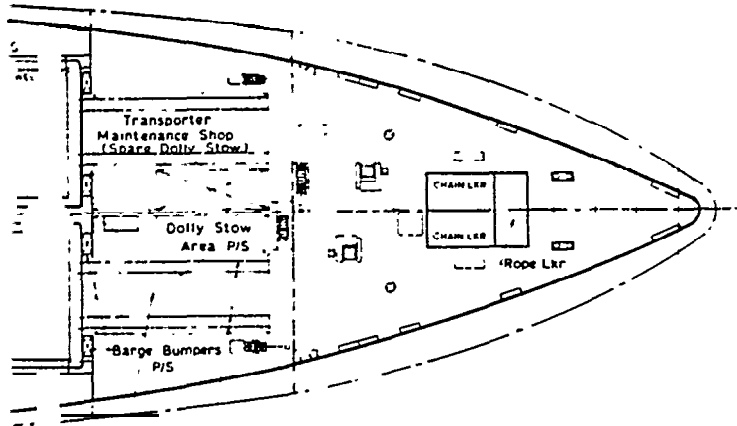
- Spray Gun
- Object Being Painted

The following safety rules must be followed when handling flammable materials.

- Spray units and their components must be grounded to prevent dangerous static sparking. Make sure the electric supply circuit is grounded as well. If spraying with a flammable material, the object being painted as well as the spray gun must be grounded to prevent static electricity from causing a spark.



- Do not spray solvent under pressure through the gun nozzle tip. An explosion or fire could result from static electricity build-up in the presence of flammable vapors. Always remove the nozzle tip from the gun before cleaning.
- Never smoke while mixing or applying paint. All sources of flame must be removed from the area where paints are mixed or applied. Extinguish all pilot lights on water heaters, furnaces, or other equipment in the area. Other crafts, such as welding, should not take place at the same time.
- In confined area, use only vapor-proof and explosion-proof electrical equipment.
- Do not work in an area when the air is not clear and free of excessive solvent odor.
- Mix all materials in a well ventilated area, away from sparks and flame.



PART C

QUIZ

UNIT V

SAFETY AND HEALTH MEASURES IN PAINT SPRAY APPLICATION

NAME: _____ DATE: _____ INSTRUCTOR: _____ GRADE: _____

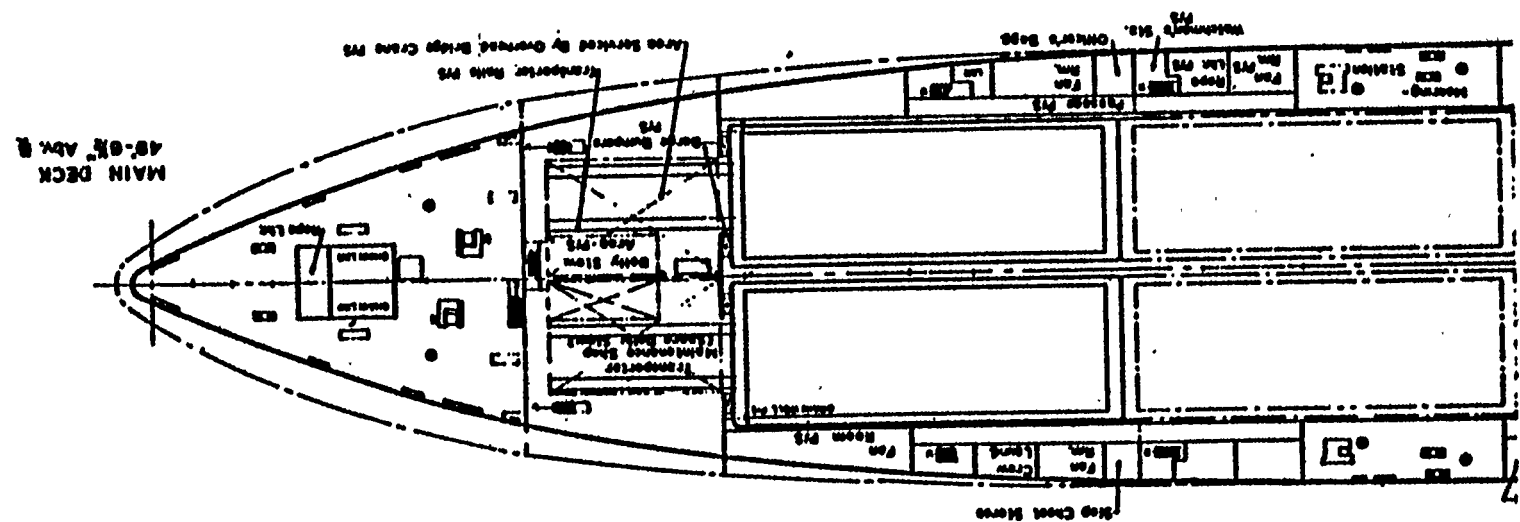
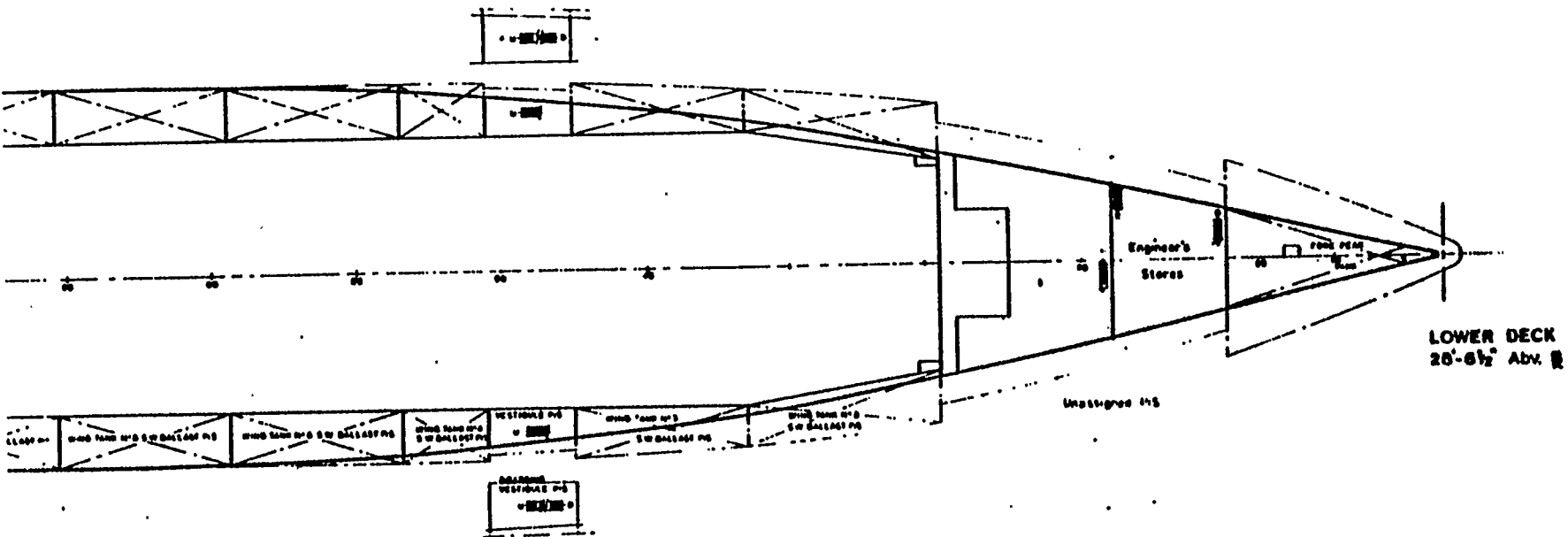
Circle the most correct answer.

1. Which two of the following solvents have the highest levels of toxicity?
 - A. xylene
 - B. naphtha
 - C. toluene
 - D. mineral spirits
2. The use of airless spray equipment requires special care because
 - A. the fluid hose can get tangled around the machinery.
 - B. at close range, its extremely high pressure can pierce the skin.
 - C. the amount of fogging is increased.
 - D. it does not use compressed air to atomize the paint material.
3. A spray gun should not be disconnected from the fluid hose until
 - A. the fluid hose has been detached from the paint pump.
 - B. the spray tip has been removed.
 - C. the pressure has been released from the hose.
 - D. the nozzle tip has been cleaned.
4. Back flushing (placing the thumb over the nozzle and releasing the trigger) a spray gun
 - A. is a recommended method for the efficient cleaning of airless equipment.
 - B. will not efficiently clean a conventional spray gun.
 - C. may be used effectively for all kinds of spray guns.
 - D. is an extremely dangerous practice to use with an airless spray gun.
5. Special spray caps are used on airless spray guns. Their purpose is
 - A. to aid in cleanliness while spraying.
 - B. to decrease the danger of piercing the skin at close range.
 - C. to maintain proper pressure at the nozzle.
 - D. to prevent obstructions from blocking the orifice.

6. A paint's ability to burn, its flammability, is measured by
- A. the temperature it can reach before catching on fire when flame is applied.
 - B. the amount of solvent contained.
 - C. the amount of volume solids contained.
 - D. the potential for being applied near an open flame.

Check the correct answer.

	<u>TRUE</u>	<u>FALSE</u>
7. The higher the flash point, the more flammable the paint.	[]	[]
8. Solvents should not be used to wash paint from the skin.	[]	[]
9. Direct contact with solvents can be dangerous because it causes the skin to dry out and become more sensitive to other dangerous materials.	[]	[]
10. Sooner or later every painter who works with amine cure epoxies will become seriously ill.	[]	[]
11. Breathing the high vapor concentrations of amines may irritate the tissues of the eyes, mouth, and nose but it may not cause damage to the entire body.	[]	[]
12. Safety instructions related to the coating material can be found in the manufacturer's data sheet.	[]	[]
13. Protective cream should only be applied to skin that is overly sensitive to solvents.	[]	[]
14. Regardless of the amount of solvent vapor and oxygen present, if a spark is introduced an explosion will occur.	[]	[]
15. Although there is the danger of fire and explosion, smoking, if done carefully, is permitted while mixing paints.	[]	[]
16. Grounding of the spray gun and the object being painted is done to prevent static electricity from creating sparks.	[]	[]



PAINr AND SURFACE PREPARATION
TRAINING PROGRAM FOR SHIPYARD PERSONNEL

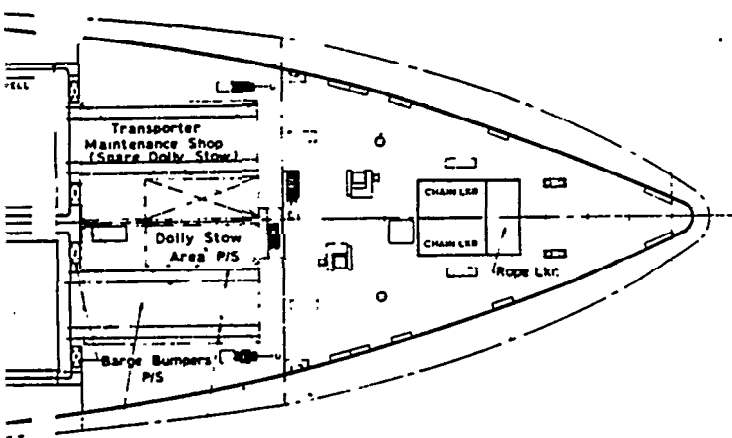
Part D: PLANNING AND SCHEDULING: THE FOREMAN'S ROLE

Unit I: Coordinating Surface Preparation and Paint Application
in the Shop

TOPICS: 1) Major Tasks of the Foreman
2) Resources Available to the Foreman

Unit II: Key Tasks of Planning, Scheduling, and Supervision

TOPICS: 1) what is Planning?
2) What is scheduling?
3) what is supervision?



PART D

PLANNING NOTES

UNIT I

COORDINATING SURFACE PREPARATION AND PAINT APPLICATION IN THE SHIPYARD

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Identify the foreman's eight major tasks for surface preparation and paint application.
2. Explain the role of the foreman in painting and surface preparation.
3. Describe the eight resources available to the foreman.

Equipment/Aids

Slide projector and screen

Time sheets and other reporting forms.

References

For further information about supervision and the role of the foreman, or first line manager, you may wish to refer to the following references:

1. George, Claude F., Supervision in Action: The Art of Managing Others, Reston Publishing Co., Inc., Reston, VA, 1982.
2. Steinmetz, L.L., Ph.D. and Todd, H.R., First-Line Management: Approaching Supervision Effectively, Business Publications, Inc., Dallas, TX, 1979.

Discussions/Group Work

One discussion area is suggested. If you choose to include this topic in your lessons, be certain that the necessary materials and equipment are available.

Topic 1. Understanding the foreman's role at your shipyard. Discuss how the major tasks of the foreman at your shipyard compare with those presented in this unit. Review and contrast the resources available to your foremen to those presented here, and discuss the objectives and key features of your management control system.

You should present copies of operational procedures, forms, and sample painting plans used in your shipyard.

Unit Quiz

An 8-question quiz is provided with this unit. Allow 5 minutes to complete the quiz. Duplicate copies for each participant. Discuss each question and answer thoroughly.

Answers to Unit Quiz D-I:

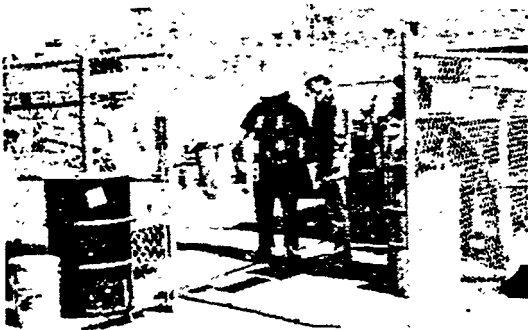
- | | |
|------|------|
| 1. B | 5. F |
| 2. D | 6. T |
| 3. c | 7. F |
| 4. A | 8. T |

COORDINATING SURFACE
PREPARATION AND PAINT
APPLICATION IN THE SHIPYARD

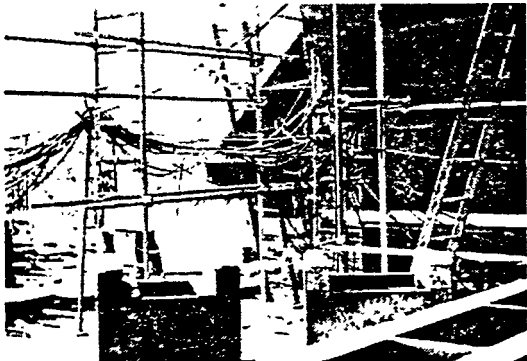
There are eight major tasks involved in shipyard surface preparation and paint application. The paint foreman is responsible for seeing that the job gets planned and that all eight tasks are accomplished -- he or she must pull the whole process together. The eight major tasks are:

1. Day-to-day planning and scheduling by the foreman.
-

2. Determining that the proper materials and equipment are available.
-



3. Rigging, scaffolding, and installation of support operations, such as electrical power, with inspection by the foreman.
-



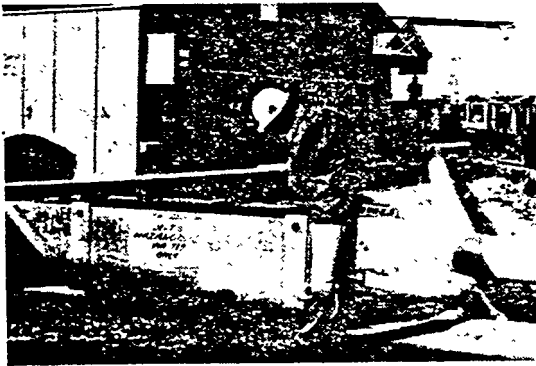
4. Preparing the surface, with inspection by the foreman.
-



-
5. Cleaning of the prepared surface, and removal of the spent blasting abrasive prior to painting.
-



- 6 painting with informal inspection by the foreman, and eventually with a formal inspection by an inspector which can be the owner's representative and/or the paint manufacturer's representative.
-



- 7 De-rigging, clean-up, and proper disposal of waste materials.
-

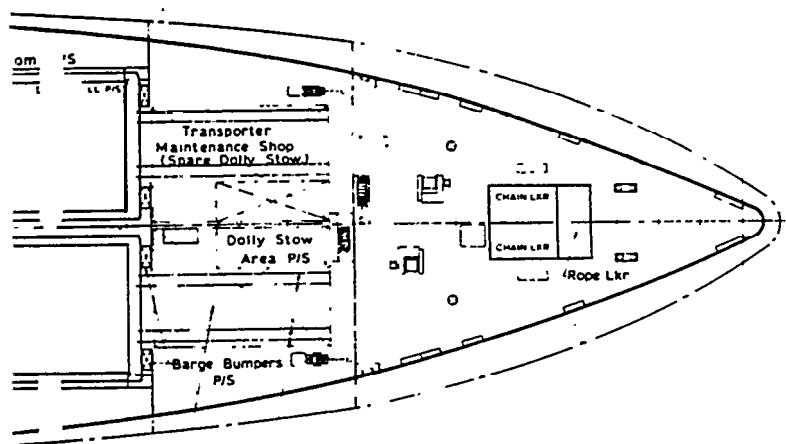
8. Reporting by the foreman to the paint department superintendent.

The painting foreman has many resources available to get the job done. He or she is the person responsible for carrying out the orders and keeping to the schedule of the shipyard by organizing the crew into an efficient workforce. The foreman takes direct orders from the paint department superintendent, and then must see that the job gets done. The many resources at the foreman's disposal include:

- . Skilled trades workers and other staff
- . Material
- . Equipment
- . Facilities
- . Time allocated for the job
- . His or her technical experience
- . Authority given by the organization
- . The shipyard's management control system -- the unique procedures, methods, systems, and techniques set up by the organization for management of the work.

The management control system created by the organization dictates, in large measure, the methods used by the paint foreman in conducting the work. For example, if there is an incentive system at the yard, the foreman and workers may tend to be more flexible in moving from one piece of work to another in order to get the job done in the minimum hours to earn the incentive. Also, the management control system spells out the types of reports that are prepared by the foreman, such as daily time sheets, progress reports, and accident reports.

Altogether, the many resources available to the painting foreman, along with his or her individual supervisory skills, make it possible for the surface preparation and painting work to be coordinated and performed within the overall schedule for construction or repair of the ship.



PART D

QUIZ

UNIT I COORDINATING SURFACE PREPARATION AND PAINT APPLICATION IN THE SHIPYARD

NAME: _____

DATE: _____

INSTRUCTOR: _____

GRADE: _____

Circle the most correct answer.

1. The paint foreman is primarily responsible for
 - A. Day-to-day planning.
 - B. Getting the work done through the efforts of others.
 - C. Inspections of prepared and painted work.
 - D. Writing daily reports.
2. Among the resources available to the painting foreman, the most important is
 - A. The shipyard's management control system.
 - B. His authority.
 - C. Shipyard facilities.
 - D. The skilled painters and blasters.
3. In coordinating the surface preparation and paint application work in the shipyard, the foreman's most important task is
 - A. Determining that 'the proper materials and equipment are available.
 - B. Filling out reports for the paint department superintendent.
 - C. Day-to-day planning and scheduling.
 - D. Attending meetings.
4. The function of the shipyard's management control system is
 - A. To monitor progress and allocate costs.
 - B. To allow the foreman to submit time sheets.
 - C. To permit paint and supplies to be ordered.
 - D. To teach the foreman how to supervise.

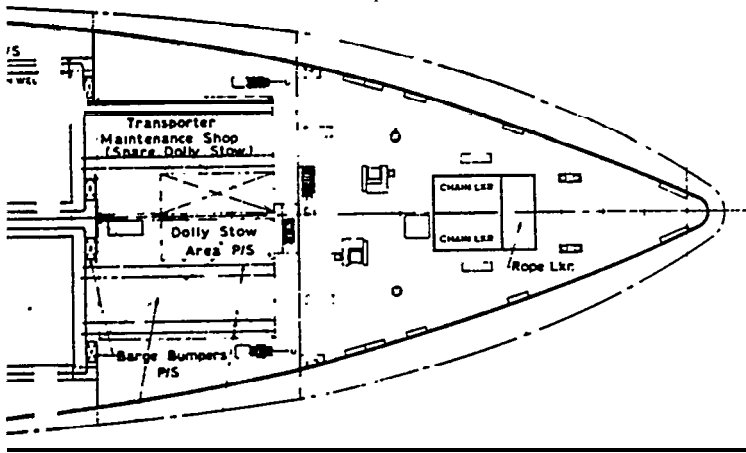
Check the correct answer.

TRUE FALSE

5. The foreman's technical skills are most important to his success as a painting and surface preparation supervisor.

[] []

6. It is the foreman who must see that the separate operations of surface preparation and painting are coordinated. [] []
7. The paint foreman does not take primary responsibility for seeing that rigging and de-rigging is done. [] []
8. The paint foreman schedules formal paint inspections. [] []



PART D

PLANNING NOTES

UNIT II

KEY TASKS OF PLANNING, SCHEDULING, AND SUPERVISION

Learning Objectives

After discussing this study unit, trainees should be able to:

1. Differentiate between shipyard planning and scheduling.
2. Identify the key tasks of day-to-day planning.
3. Identify the key tasks of daily scheduling.
4. Identify the supervisory responsibilities of the shipyard paint and surface preparation foreman.

Equipment/Aids

Slide projector and screen

Time sheets, accident report forms, personnel policy manual, typical work schedules or work flow charts, and other relevant forms.

References

1. George, Claude F., Supervision in Action: The Art of Managing Others, Reston Publishing Co., Inc., Reston, VA, 1982.
2. Steinmetz, L.L., Ph.D. and Todd, H.R., First Line Management: Approaching Supervision Effectively, Business Publications, Inc., Dallas, TX, 1979.

Discussions/Group Work

Two discussion areas are suggested. If You choose to include these topics in your lessons, be certain that the necessary materials and equipment are available.

- Topic 1. How planning and scheduling is done at your shipyard. Review the procedures, forms, and reporting sequence used in the paint department. Compare and contrast these techniques with the

various planning and scheduling tasks outlined in Sections 1 and 2 of this unit. Follow-up with a review of what supervisory functions the foremen in your shipyard perform, compared to those described in Section 3 of this unit.

Topic 2. Planning and scheduling a typical job. Divide the participants into groups of 5 or less. Their assignment is to plan and schedule the blasting and painting of a ballast tank on board ship.

They will need the following information to complete this task.

1. The size of the tank in square feet. You may use 30,000 Sq. ft. as a figure or another typical size.
2. The paint system to be used. Any epoxy system may be specified.
3. The surface profile needed and standard of cleanliness for the substrate.
4. The number of coats needed, including primer, the WFT for each coat, and the total DFT for the system.
5. The cost of the paint per gallon.
6. The type of abrasive used and its cost.
7. The number of calendar days allocated for the job.
8. The hourly rates of the workers and supervisors involved.

Working separately, each group should complete a written estimate and outline that includes:

1. The overall plan of the job, listing the major tasks in sequential order.
2. The number of staff days required to do the job within the time allocated. (They may want to use the shift schedule in operation at their yard or you can suggest a 3-shift day.)
3. The number of workers and supervisors needed to complete the job. Include blasters, painters, and support personnel like cleaners and electricians.
4. The total labor costs and the labor costs for each task.
5. The amount of paint needed.
6. The amount of abrasives needed.

7. The total cost of paint.
8. The total cost of abrasives.

You will need to supply each group with the following materials:

1. Copies of the blasting and painting specifications for the tank.
2. Copies of the paint manufacturer's data sheet for the paint system to be used.
3. Hand calculator for each group.

You will need to write out the assignment on a chalkboard or flipchart, or make copies of it and hand them out.

AS an option, you may want to have the groups follow the format of a typical painting plan used in their shipyard, and fill out typical report forms, such as time sheets.

Allow one (1) hour for the groups to complete the assignment, and one (1) hour for discussion.

Notes:

1. This exercise assumes that the participants are familiar with shipyard surface preparation and painting theory and techniques.
2. You may want to use the shipyard's paint and planning departments as resources for providing material costs, labor rates, standard forms, etc.

Unit Quiz

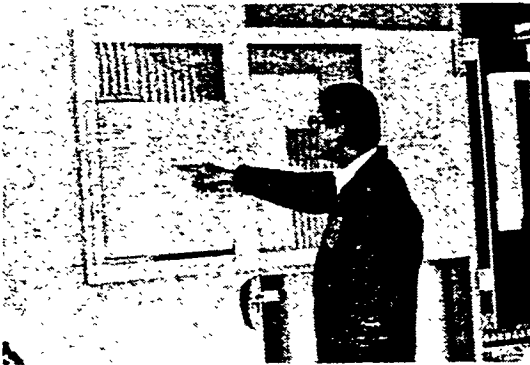
An 8-question quiz is provided with this unit. Allow 5 minutes to complete the quiz. Discuss each question and answer thoroughly.

Answers to Unit Quiz D-II:

- | | |
|------|------|
| 1. B | 5. T |
| 2. B | 6. T |
| 3. D | 7. T |
| 4. F | 8. T |

KEY TASKS OF PLANNING,
SCHEDULING, AND SUPERVISION

Planning, at the shipyard painting foreman's level, is the critical first task that must be done before anything else. Planning involves determining what must be done, when it must be done and how it is to be done. Planning also includes another important function--reporting what has been done to the paint department superintendent so that the shipyard planning department can be informed in order to update the master schedule and make changes as needed. Planning by the painting foreman must be done in coordination with the planning activities of the paint department. This typically requires attendance at meetings with the superintendent and other foremen to determine near-term objectives and to organize the work. Meetings are likely to be held on a daily basis, with longer meetings being held weekly. The key tasks of planning for the painting foreman include the following items.



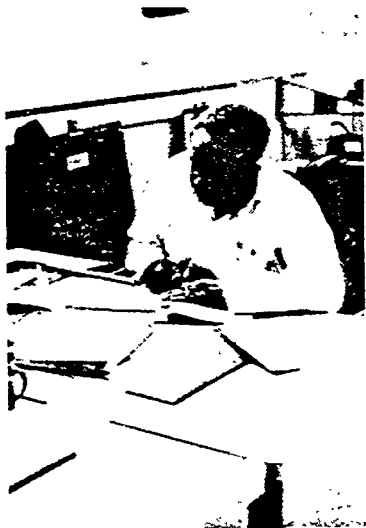
Determining the work to be done in the immediate future from the master schedule and from the painting schedule.



Estimating, along with the paint department superintendent, the length of time and the number of workhours needed to accomplish the work, and comparing these to the budgeted hours.



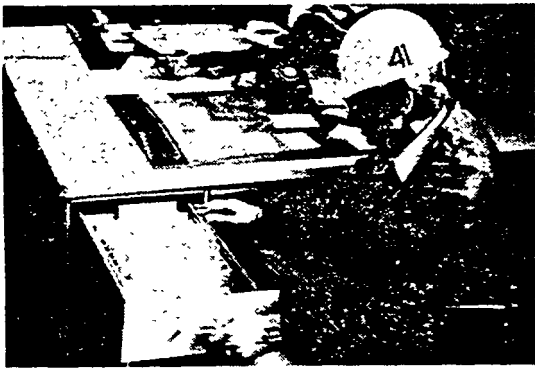
Reviewing the physical lay-out and the needs of the next job in advance of the time the work is to begin.



Providing daily time and progress reports to the superintendent. These are used to update the master schedule and to compare the workhours used against those budgeted for the job.

2. WHAT IS SCHEDULING?

Scheduling for the paint foreman is the next step beyond planning and involves job-specific details to accomplish the work. Through scheduling, the foreman uses his or her individual skills and experience to organize the crew of blasters and painters into an efficient work group. The foreman needs to be flexible as well as imaginative to keep the work going and to keep the crew busy. The key tasks of scheduling for the paint foreman are:



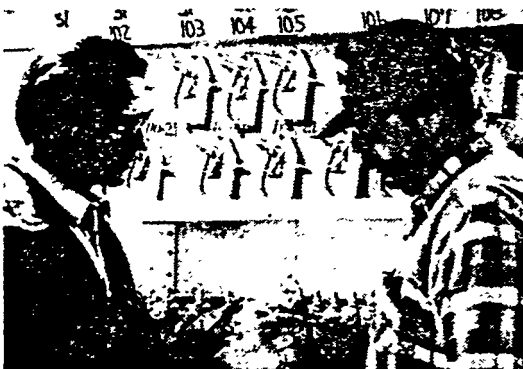
Determining the sequence of work on individual jobs, and moving workers between-different jobs as needed.



Confirming what paint systems are to be used and what colors will go where. For example, a typical module will have as many as three paint systems and colors because it may include parts of the deck, hull and interior passageways. The foreman must review the manufacturer's data sheets for the paint systems and the standard paint specifications and paint schedule for the vessel being constructed or repaired. It is vitally important that the foreman know the proper surface preparation for each paint system, especially where abrasive removal of shop primer is required.



Determining the paint inventory in the store-room and the materials needed, including major equipment such as dehumidifiers, heaters, and ventilation equipment. Arranging for support facilities, rigging, and lighting and determining safety requirements.



Communicating with other crafts ahead of time regarding access to the work and elimination of intercraft interferences. This is particularly important for on-block and on-ship work.





Monitoring the work as it progresses and scheduling inspections with the Q/A department both for informal inspections, such as routine surface preparation checks, and formal inspections, which might include the owner's and the paint manufacturer's representative as well as the shipyard paint department superintendent and Q/A personnel.



Checking that the pre-outfitting of modules and blocks, which should be done before painting, has actually been done. While it may be the responsibility of another department to assure that pre-outfitting is done, it is only prudent for the paint foreman to make sure the work is ready before painting begins .

3. WHAT IS SUPERVISION?

Supervision encompasses the activities required to get things done through the efforts of others. The painting foreman is the first-line supervisor who must be able to organize the workers to accomplish the work. He or she must understand and be able to motivate them, be a good planner, be able to allocate work, be competent in the technical aspects of surface preparation and painting, be a good leader, and be an effective link between the workers and upper management, especially the paint department superintendent. The paint foreman is the key person that carries out the objectives of the paint department. The foreman must use his or her technical, human and conceptual skills to plan the work, organize the people to do the work, direct the efforts of the crew as it does the work, and, finally, control the activities through monitoring and formal reporting to the paint department superintendent. Key tasks that the foreman must do to accomplish these responsibilities include the following.

Knowing and following the established shipyard procedures, where possible.



Assuring that the day's work is ready and safe at the beginning of the shift. In the case of shop work, seeing that the modules or units to be painted are at hand. Making sure that water, ice, and debris are removed from modules before work begins.



Attending morning organizational meetings and other scheduled foremans' meetings.

Finding out what the weather conditions and forecast are. Checking the temperature, relative humidity, dew point at the job site, and the surface temperature of the substrate to be painted.



Assigning work to the crew and organizing the blasters, painters, and helpers into teams.



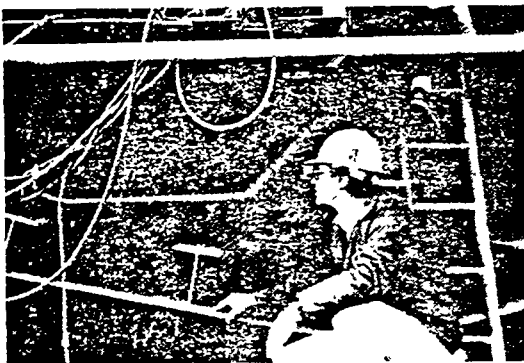
Keeping the crews busy with good planning and scheduling to avoid unproductive time. Having alternate work areas in mind. Being flexible and mobile!



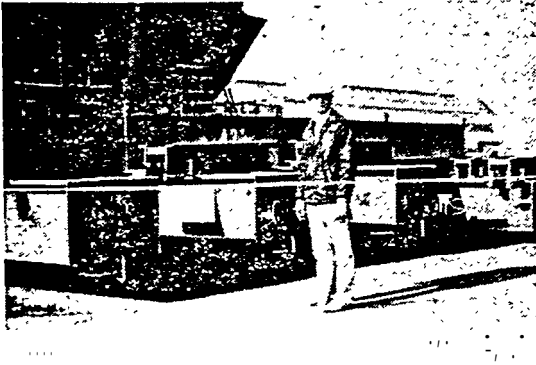
Monitoring the work force during the shift and being available to handle problems. Being with the work crew is a major activity of the painting foreman.



Making inspections for surface preparation and paint thickness (wet film and dry film) and keeping records. The foreman should know the standards for which the inspection is being done. Scheduling and attending formal paint inspections.



Coordinating with other craft supervisors on an almost continuous basis, particularly for on-block and shipboard work.



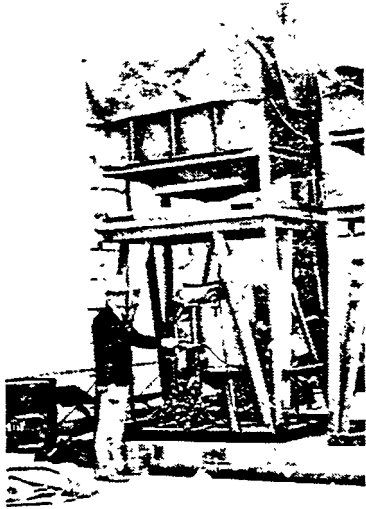
Checking that ventilation, lighting, heat, hand rails and other staging are in place.

Posting warning signs and roping off the work area.



Monitoring the safety of the work area and being prepared to take quick action to eliminate unsafe conditions.





Inspecting major equipment such as blasting apparatus for defects and seeing that preventive maintenance is done.



Acting as the shipyard's first line for quality control through monitoring and inspection activities.





Communicating with other shift supervisors orally and with written logbooks.



Keeping track of the crew's time, recording hours, location where worked, unit or block number, and activities.

Providing daily written progress reports for the paint department superintendent and updating workhour expenditure records. Also giving informal feedback on work progress.

Filling out special reports, such as accident reports.

(sorry, no pictures of gang showers!)

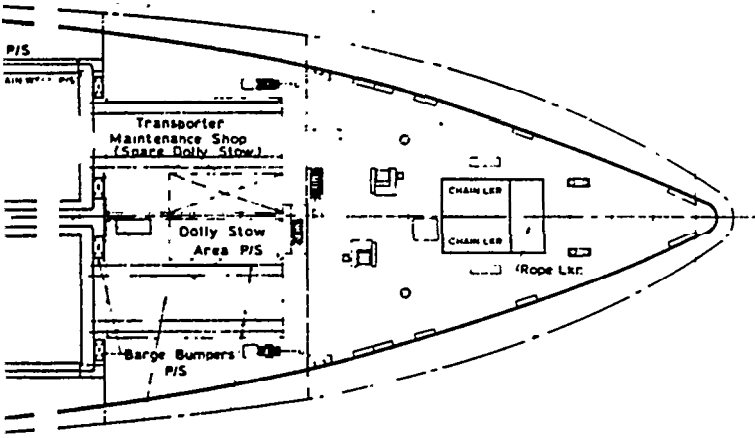
Assuring that the crews have sufficient time before the end of the shift to clean up the area and equipment and to clean up themselves, take showers, etc.



Assuring the proper clean up of the blasting and painting work areas, and the safe and legal storage and disposal of hazardous waste materials, such as solvents, unused and outdated paint, and empty paint and solvent cans.



Keeping track of the welfare of the workers and being prepared to help when problems arise.



PART D

QUIZ

UNIT II

KEY TASKS OF PLANNING, SCHEDULING, AND SUPERVISION

NAME :

DATE :

INSTRUCTOR:

GRADE:

Circle the most correct answer:

1. Planning and scheduling for the paint foreman differ because
 - A. Planning comes before scheduling and is more job specific.
 - B. Scheduling deals with the daily details of specific jobs, but planning is used to determine what, when, and how jobs are to be done.
 - C. Planning comes after scheduling, but scheduling is more job specific.
 - D. Planning includes reporting to the paint department superintendent, but scheduling does not.
2. Which of the following is not one of the key tasks of planning.
 - A. Estimating the number of workhours needed for a job.
 - B. Monitoring the work force.
 - C. Updating the master schedule.
 - D. Estimating how long it will take to do a job.
3. During scheduling of several jobs for a typical day, the paint foreman must set priorities by
 - A. Referring to the master plan for a vessel and communicating with the paint department superintendent.
 - B. Communicating with other crafts.
 - C. Knowing the status and progress of all current and future work he/she is responsible for.
 - D. All of the above.
4. Key supervisory tasks for the foreman include
 - A. Assigning work to the crew.
 - B. Monitoring the work force.
 - C. Conducting inspections.
 - D. Determining the paint inventory in the storeroom.
 - E. A and B only.
 - F. A, B, and C only.
 - G. A, B, C, and D.

Check the correct answer.

	TRUE	FALSE
5. The foreman must look out for the welfare of his/her workers.	[]	[]
6. The foreman's job requires that he/she be responsive to the workers and to upper management.	[]	[]
7. The foreman must be flexible as a supervisor, but must follow established shipyard procedures.	[]	[]
8. The foreman is the most effective representative of shipyard management for assuring safety in the work area.	[]	[]

PAINT AND SURFACE PREPARATION
TRAINING PROGRAM FOR SHIPYARD PERSONNEL

APPENDIX

Glossary of Key Terms

Standards

References

Resource Organizations

PAINT AND SURFACE PREPARATION.

GLOSSARY

- ABRASION - being worn away by rubbing or friction
- ABRASION RESISTANCE - resistance to being worn away by rubbing or friction; related to toughness, rather than the hardness of a paint film
- ABRASIVE - the material used for abrasive blast cleaning, such as sand, mineral grit, steel shot or steel grit
- ADHESION - bonding strength; the attraction of a coating to the surface to which it is applied
- AGITATE - to stir or shake
- AIR COMPRESSOR - a separate piece of equipment in spray systems which draws in air and compresses it, thus providing high pressure and volume of air required for abrasive blasting and spray painting
- ALKALI - a substance such as lye, soda, or lime that can be highly destructive to paint films; caustic
- AMBIENT TEMPERATURE - room temperature or temperature of surroundings
- ANCHOR PATTERN - a rough pattern of peaks and valleys caused by abrasive blasting which improves the ability of the paint to bond to the steel surface
- ANTIFOULING - coating containing toxic ingredients, such as cuprous oxide, applied to shipbottoms to prevent marine growth
- ATOMIZE - to reduce a liquid to a mist; to break a stream of paint into small particles
- BINDER - the resin, or film-forming ingredient in paint, that binds the pigment particles together
- BLAST PATTERN - the surface area hit by the abrasives: the closer the nozzle is held to the surface, the smaller the blast pattern
- BONDING - a mechanical attraction between two surfaces, such as two coats of paint or paint and a substrate. The mechanical "holding effect" between paint and steel, for example, may be increased by roughening the steel surface
- BOUNCE-BACK - spray paint rebound from the surface
- BOXING - manual mixing of paint by pouring back and forth from one container to the other
- BREAKDOWN CHARACTERISTICS - the extent to which an abrasive pellet is damaged after striking the work surface; related to the recyclability of an abrasive and degree of dusting
- BRONCHITIS - an inflammation of the mucous lining of the bronchial tubes

BURNISH - to make shiny by rubbing or polishing. Burnished metal is a poor surface for paint bonding.

BURR - a raised "splinter" on a metal surface which will interfere with coating performance

CAMOUFLAGE - the process of disguising or changing the appearance of a ship to blend into the background

CATALYST - curing agent; hardener

CFM - cubic feet per minute; the capacity, or the air volume, of an air compressor is measured in CFM units

CHALKING - loss of gloss; powdery surface, usually due to the weathering of paint films

COBWEBBING - a stringy, thin spray pattern. This paint film defect is frequently of paint being delivered to the surface.

CONDENSATION - to become more dense, as a vapor into a liquid. Moisture may appear on a surface as an almost invisible film or as water.

CONTAMINANT - dirt, oil, grease, loose rust, paint, or mill scale, which must be removed from the surface for paint to bond securely

CORROSION - gradual destruction of a material, such as metal, due to interaction with the environment

CURING - hardening; setting up

DEADMAN VALVE - shut-off valve at the blast nozzle, which allows the blaster to start or stop the abrasive flow

DEFECT - imperfections in the paint film which can lead to early paint failure

DEHYDRATION - loss of moisture or fluid; to dry out

DERMATITIS - skin irritation or rash

DETERIORATION - the gradual decay of a material; as a paint film ages with exposure to sun, rain, and chemicals, its protective qualities deteriorate and corrosion can begin

DEW POINT - temperature at which moisture condenses

DISPERSE - to break up and distribute in different directions. In mixing a paint, the pigment must be evenly distributed.

time interval between application and ability to touch a painted surface without damage

DRY TO RECOAT - time interval between application and ability to receive next coat satisfactorily

EROSION - wearing away of a surface. Heavy chalking tends to accelerate erosion of a paint film. Water flow over a ship's propeller causes metal erosion.

EVAPORATION - the release of solvents from the paint fluid into the atmosphere

FAILURE - loss of adhesive and/or protective qualities of a paint film which can no longer serve its function as a barrier to corrosion

FILM THICKNESS - depth of applied coating, usually expressed in mils (metric: microns)

FLAMMABILITY - ability to burn

FLASH POINT - the lowest temperature at which a flammable material will ignite if a flame or spark is present

FOULING - growth of attachments, such as weeds or barnacles, to hulls of ships or other marine structures

FRICTION - the rubbing of one object against another

GENERIC - a class or group; generic paint types take their name from the kind of resin in the formulation -- alkyd, epoxy, etc.

GLOSS - ability to reflect; shininess; luster; brightness

GROUNDING - dissipation of electrostatic charge

HORSEPOWER - a unit for measuring the power of motors or engines (equal to a rate of 33,000 foot-pounds per minute); abbreviated HP

HYPODERMIC NEEDLE GAUGE - a gauge inserted into the blast hose close to the nozzle to measure air pressure at the nozzle

HYDROBLASTING - water blasting; the use of water pumped at extremely high pressures to remove unwanted materials from a surface

IMMERSION - completely covered by water; submerged

IMPACT - striking together; collision

IMPERMEABLE - not permitting the passage or penetration of moisture, air, or other substance

INDUCTION TIME - the length of time that a mixed catalyzed paint must stand before it is ready to apply (also called "setting up" or "sweating in" time)

- INTERIOR DIAMETER (ID) - measurement across the inside width of a hose, usually expressed in inches
- IRON OXIDE - a combination of iron (Fe) and oxygen (O₂); "rust" is a form of iron oxide
- MIL - one one-thousandth of an inch; .001"; 1/1000 inch
- MILL SCALE - layer of iron oxide, bluish in appearance, formed on the surface of steel during manufacture
- MISTCOAT - a heavily thinned coat of paint (approximately 90% solvent) applied in a thin film (approximately .5 mil) to "re-flow" the previous coat of paint; also used on porous films such as inorganic zinc to seal pores for topcoating
- ORIFICE - opening or hole, as in a spray gun fluid tip
- OVERSPRAY - fluid that is lost by missing the surface to be painted
- PASS - motion of the spray gun in one direction only; one stroke
- PEEN - to hit the surface leaving rounded indentations, providing a wavy anchor pattern
- PERMEABLE - allowing passage or penetration
- PIGMENT - paint ingredient used mainly to impart color, hiding power, and protection
- POTABLE WATER - drinkable water
- POT LIFE - the time after the catalyzed paint has been mixed during which the material is usable -
- PRIMER - the first of two or more coats of a paint system; usually a rust-inhibitive coating when used over ferrous metal
- PROFILE - surface contour of a blast-cleaned surface as viewed from the edge; improves the ability of the paint to bond to the surface
- PSI - pounds per square inch; a measure of force, such as the air pressure at the blast nozzle
- PSYCHROMETER - an instrument with wet and dry bulb thermometers for measuring the amount of moisture in the air
- RESIN - a major ingredient of paint which binds the other ingredients together and imparts protective properties
- RESPIRATOR - a device worn over the mouth and nose to prevent inhaling harmful substances such as dust, solvent vapors, fumes, etc. Respirators may be cartridge, filter, or air-fed.
- .

- SHELF LIFE - maximum amount of time in which a material may be stored and remain in usable condition
- SILICOSIS - a type of respiratory disease caused by silica particles lodged in the lungs
- SKIDDING - a paint roller sliding across a surface leaving roller tracks; caused by too little or too much paint on the roller cover
- SOLVENT - liquid ingredient of paint, the function of which is to dissolve the resin so that it may be applied easily
- SPRAY FAN - shape of the spray pattern
- SPRAY PATTERN - description of the shape and size of the paint mist when it strikes the surface; varies from a circle to a long narrow oval
- SUBSTATE - surface to be painted
- SURFACE PREPARATION - all operations necessary to prepare a surface to receive a coating of paint
- THINNER - liquid added to a coating to adjust consistency
- THIXOTROPIC - a gel which becomes a liquid when stirred but gels again on standing; "false-bodied"
- TOOTH - surface roughness which improves the ability of the paint to bond to the surface
- TOXIC - poisonous
- TIECOATING - application of a thin adhesive coat to aid in the bonding of two coats of paint
- VEHICLE - liquid portion of a coating; made up of binder and solvent
- VENTURI NOZZLE - nozzle with a tapered lining shape; it increases abrasive speed and creates a larger, more even blast pattern
- VISCOSITY - a measure of how fast or how slow a liquid flows
- VOLUME SOLIDS - the percentage of the total volume occupied by non-volatiles (paint solids)
- WELD FLUX - deposits of the fluxing (flowing) agent which, when left on the metal around a weld seam, may cause paint adhesion problems
- WELD SPLATTER - beads of metal scattered next to the weld seam; these interfere with paint adhesion and should be removed

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NFPA 312, Fire Protection of Vessels During Construction, Repair, and Lay-up
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NFPA 325M, Fire Hazard Properties of Flammable Liquids, Gases, Volatile Solids
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 - 1915.25, Flammable Liquids
 - 1915.57, Health and Sanitation
 - 1915.58, First Aid
 - 1915.81, Eye Protection
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 - SSPC-SP2-63 No. 2 Hand Tool Cleaning
 - SSPC-SP3-63 No. 3 Power Tool Cleaning
 - SSPC-SP4-63 No. 4 Flame Cleaning of New Steel
 - SSPC-SP5-63 No. 5 White Metal Blast Cleaning
 - SSPC-SP6-63 No. 6 Commercial Blast Cleaning
 - SSPC-SP7-63 No. 7 Brush-Off Blast Cleaning
 - SSPC-SP10-63T No. 10 Near-White Blast Cleaning
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RESOURCE ORGANIZATIONS

.The following organizations and government agencies have publications, standards, or programs which are relevant to coating work in the shipbuilding industry. For further information, they can be contacted at the addresses below.

American National Standards Institute (ANSI)

1430 Broadway
New York, N.Y. 10018
212/354-3300

The American National Standards Institute was founded in 1918 by ASTM and four other societies to serve as a clearinghouse for standards activities. With nearly four hundred organizations of various types writing standards in the United States, ANSI's role is to 1) reduce overlap and duplication of effort, 2) point out where standards are needed and lacking, 3) recognize and identify nationally accepted standards, and 4) serve as the United States representative in international standards activities.

In shipyard coating operations, applicable ANSI standards which should be considered are those which deal with safety codes and practices.

American Society for Testing and Materials (ASTM)

1916 Race Street
Philadelphia, PA 19103
215/299-5400

The American Society for Testing and Materials is a non-profit corporation formed for the development of standards on characteristics and performance of materials, products, systems and services and the promotion of related knowledge. In ASTM terminology, standards include test methods, definitions, recommended practices, classifications, and specifications.

ASTM is a management system for the development of voluntary full consensus standards. It provides a legal, administrative, and publications forum within which producers, users, and those representing the general interest can meet the needs of all concerned.

Standards specifically for shipbuilding and coating are developed by the D-1 Committee on Paint and Related Coatings and Materials and the F25 Committee on Shipbuilding.

Maritime Administration (MarAd)

U.S. Department of Commerce
Room 3895 - Commerce Building
14th & E Streets, N.W.
Washington, D.C. 20230
202/377-2000

The Maritime Administration is an agency of the U.S. Department of Commerce which is charged with the responsibility of developing and maintaining a merchant marine capable of meeting the Nation's defense and commercial trade requirements.

The National Shipbuilding Research Program, which is a cost shared effort by industry and MarAd, sponsors training programs and research projects.

National Association of Corrosion Engineers (NACE)

P. O. Box 986
Katy, Texas 77450
713/492-0535

National Association of Corrosion Engineers is a professional membership society which creates standards and educational programs in the field of corrosion control. The Association publishes monthly journals, books, and standards concerning corrosion control in the industrial community. In addition, over two hundred Technical Practices Committees publish reports and standards for anti-corrosion techniques. An Annual Conference, technical committee meetings, and corrosion courses serve as a forum for discussion, education, and solutions to the problems of corrosion.

The NACE Visual Standards for blast cleaned steel surfaces are relevant to shipyard coating work operations.

National Fire Protection Association (NFPA)

470 Atlantic Avenue
Boston, Mass. 02210
617/482-8755

The National Fire Protection Association is a national non-profit membership organization concerned with eliminating and preventing fire and explosion in homes, business, and industry. The Association develops, publishes, and disseminates standards designed to meet this goal. In addition to its publications, films, and training packages, the Association is also a clearinghouse for other fire prevention information and provides field service.

Standards and recommendations are available concerning coating work practices during ship construction and repair.

National Institute for Occupational Safety and Health (NIOSH)

5600 Fishers Lane
Rockville, Maryland 20857
301/443-2140

The National Institute for Occupational Safety and Health is the principal federal agency engaged in research to eliminate job-related illness and injury. NIOSH is responsible for identifying occupational safety and health hazards and for recommending standards to the Department of Labor. Under the Occupational Safety and Health Act of 1970, NIOSH conducts research for new occupational safety and health standards. It is established within the Department of Health, Education and Welfare. Studies underway include investigations of the possible health hazards to which painters and blasters are exposed.

National Safety Council

444 No. Michigan Avenue
Chicago, Illinois 60611
312/527-4800

The National Safety Council, founded in 1913, is a non-profit, public service organization formed to reduce both the number and the severity of accidents. It gathers, analyzes, and distributes safety information through a variety of publications and programs. Members of the Council receive safety materials, such as books, magazines, newsletters and training aids.

Safety data sheets and safety practices pamphlets pertaining to shipyard coating work are available.

Occupational Safety and Health Administration (OSHA)

U.S. Department of Labor
Occupational Safety & Health Admin.
Washington, D.C. 20210
202/523-8148

Under the Occupational Safety and Health Act of 1970, the Occupational Safety and Health Administration was created within the Department of Labor to:

- encourage the reduction of workplace hazards and to implement new or improve existing safety and health programs;
- achieve better safety and health conditions;
- establish procedures for reporting and recording job-related injuries and illnesses; and
- develop mandatory job safety and health standards and enforce them effectively.

In addition to the General Industry Safety and Health Standards (OSHA 2206, 29 CFR 1910), OSHA has published a set of standards specifically for the shipyard industry (see Standards).

Painting and Decorating Contractors of America (PDCA)

7223 Lee Highway
Falls Church, Virginia 22046
703/534-1201

Established in 1884, the Painting and Decorating Contractors of America is a nationwide trade association. The purpose of PDCA is to determine and fulfill the needs of its members, the qualified painting, decorating, and drywall contractors. PDCA compiles and disseminates information and ideas to its members through its various publications, which include a textbook and manual, a monthly publication and chapter bulletins. Some of the other services of this organization include apprentice training, technical information distribution, and an annual convention.

Society of Naval Architects and Marine Engineers (SNAME)

One World Trade Center
Suite 1369
New York, N.Y. 10048
212/432-0310

The Society of Naval Architects and Marine Engineers is an internationally recognized non-profit, technical, professional Society of individual members serving the maritime and offshore industry and its suppliers. SNAME is dedicated to advancing the art, science and practice of naval architecture, shipbuilding and marine engineering, encouraging the exchange and recording of information, sponsoring applied research, offering career guidance and supporting education, and enhancing the professional status and integrity of its membership.

The Society's scope includes all aspects of research, design, production, maintenance and operation of ships, submersibles, yachts, boats, offshore and ocean bottom structures, hydrofoils and surface effect ships. It administers and supports an extensive Technical and Research (T & R) Program involving over 900 individuals as voluntary members and permanent staff in cooperation with government and regulatory agencies, scientific and research laboratories, academic institutions, and the marine industry.

Founded in 1893, the Society comprises more than 10,000 individuals throughout the United States, Canada and abroad.

Steel Structures Painting Council (SSPC)

4400 Fifth Avenue
Carnegie-Mellon Institute
Pittsburgh, PA 15213
412/578-3327

The Steel Structures Painting Council is a non-profit research association, supported by voluntary contributions from organizations concerned with the manufacture, specification, or use of paints or other coatings for the protection of steel surfaces. Organized in 1950 through the efforts of the American Institute of Steel Construction, they have since been joined by 16 other association members and 29 patron members.

The purposes of the SSPC are as follows:

1. To review the art of cleaning and painting steel structures.
2. To issue, if found feasible, a code or specification covering practical and economical methods of surface preparation and painting of steel structures.
3. To perform in its own organization, or by engaging outside individuals or organizations, further research to reduce or prevent the corrosion of steel structures by surface preparation and by the application of paint and coatings.
4. To issue recommendations to further improve and make more economical the protection of steel structures.

Currently some eleven standards relating to surface preparation and paint thickness measurement have been issued (see Standards).

THE
SUPERVISOR
AS
INSTRUCTOR



THE SUPERVISOR AS INSTRUCTOR

Your Role As Instructor

Based on your knowledge and experience in the shipyard, you have been selected to be an instructor in the Paint and Surface Preparation Training Program for Shipyard Personnel. Your role as an instructor is to train the first-line paint supervisors in your own shipyard who are responsible for communicating the fundamentals of quality and efficient directions to the painters and blasters.

You probably have never been a formal instructor before, but you have taught operators in an informal way. Every time you show a new painter how to hold a spray gun, or how to mix paints, you are acting as an instructor. When less experienced workers observe what is going on around them, they are picking up information about how to do a job. Although you may not realize it, you are training others as they watch you.

The problem with this kind of learning is that no one is perfect. A new painter can learn how to do something the wrong way as easily as he can learn the right way. Everyone in the shipbuilding industry agrees that painting and blasting are important jobs that must be done correctly. The only way these jobs can be done to satisfaction is if the supervisors are knowledgeable and can properly teach their work crews.

Because of the type of job a supervisor has, he cannot work efficiently by himself. A supervisor's work is often judged by how well his crew works. As a supervisor, you must be able to transmit your knowledge and skills to the other workers. The best way to do this is through training. A good supervisor is also a good trainer. Training and reinforcing in order to help operators do a job correctly is a major part of being a supervisor.

Besides communicating knowledge and improving skills, a supervisor must motivate the operators. Before anyone will do a better job, he must understand the importance of his job. Operators who attend a training program must understand the reason it is being given and why they have been sent. Most adults learn best when they feel there is something they can learn. A training program will be well received by the operators if they recognize the immediate benefits and the ways in which the program can help them in their daily jobs.

Your role as an instructor is to promote knowledge, comprehension, and skills among the operators. Your knowledge of the subject matter is the tool by which people are successfully trained.

The Training Process

While informal training relies mainly on experience, knowledge, and skills, more formalized training requires some planning in advance. The job of instructor is challenging, but it is not always difficult. Think back to all of the informal training you have done and apply all your experience to this new kind of situation. Once you have practiced for a while and have become familiar with these materials, you will probably find that training is not that difficult.

To help you in your role as an instructor, there are some useful guidelines to remember.

Planning The Lesson

Be prepared. Before you have to present any material to the trainees, review it by yourself. It is a good idea to practice out loud to someone at home or in front of a mirror. Make sure that you are familiar with the topics to be discussed. Be ready to answer questions and discuss different points of view.

Introduce examples and stories from your own experience. This will make your presentation more interesting. Examples of this kind will hold the interest and attention of the trainees and it will help them to remember important points. As you read through the Instructor's Manual, make notes in the places where you have relevant examples. Relate the material to jobs in progress or recently completed in your yard. If you have slides, drawings, blueprints, or work samples to supplement the materials which are provided, use them. The more specific you can be in relating the program contents to the work in your yard, the easier it will be for the trainees to see how this information can help them on the job.

Establish a schedule. Know which topics you will have to discuss. Advance planning eliminates the feeling of being unprepared in front of a group of people. If you plan, you will know where to start and finish each discussion and when to use the slides or blackboard to emphasize your point. Set a time schedule and stick to it. A well prepared lesson also makes a good impression on others and makes learning easier for them.

Use the planning notes. They are provided at the beginning of each unit in the instructor's manual. These notes cover the topics in each unit, the learning objectives, how long it should take to discuss the whole unit, the demonstration and discussion topics, the type of equipment and slides you will need for the unit, and the answers to the unit quiz.

Refer to the demonstration notes. They will tell you exactly what kind of equipment you will need. Make sure you have all equipment ready and in working order before the trainees arrive.

Classroom Training Tips

Being a good instructor is more than being very knowledgeable. Not only must you know the material, you must also be able to get it across to the trainees.

- . At the first meeting, introduce yourself to the group. State the purpose of the program and why the participants were chosen. Allow each trainee to introduce himself, including information on his job and experience. State how long the training period will last, when the group will meet again, what is expected from them and how their performance in the program will be evaluated. Answer any questions which may arise at this time. .

Present the material in a simple, direct, and clear manner. Get to the main points quickly, but don't hurry or skip over important topics. What may seem basic may be new to many trainees.

- Discuss only one topic at a time. A good presentation is generally kept short, but complete. Cover all the information necessary for one topic and then move on to the next.
- Modify the training material to suit the conditions of your yard or paint shop. Explain the way things are done where you work. It is not a good idea for trainees to learn something that is not done exactly the way they will be expected to work. Refer to the notes you have made about your own experiences. You can work these into the presentation and discuss them without interrupting the flow of the material. If properly placed, these notes will help the flow of the presentation.
- Whenever possible, encourage participation in the way of discussions and questions. Get to know the level or experience of the students and draw them into discussion. Group discussions can tell you how well the material is being understood. Ask questions of the entire group and

encourage discussion of alternative viewpoints. Avoid picking on any one student and do not ask confusing or trick questions.

- . Remember that adults learn best by doing. In improving skills, it is a good idea to let the trainees use what they have learned before they forget, or dismiss it from their memory. Always carry out the demonstration and field practices indicated in the manual. Plan to bring examples of equipment into the classroom whenever possible. On the job, reinforce what was taught in class.

Keeping Group Interest

Your presentations will probably not be made to very large groups of people. However, even with small groups, there are some important things to remember about maintaining the interest of the trainees.

- . You are not really training a group of people. Rather, you are training several individuals at the same time. Each person brings to the class a slightly different background and set of experiences. One of the benefits of training a group is that individuals can interact and learn from each other.
- Make sure each member of the group fully understands every point. Do not go on to new points until everyone understands what has already been discussed.
- . An effective trainer must have the cooperation of the trainees, just like a supervisor must have the cooperation of the operators. To hold their attention and maintain the level of interest, relate your discussion to their experiences and build upon what they already know.
- . Try to get the undivided attention of your audience. Sometimes in a group there are situations that make training difficult, such as noise and interruptions. Try to maintain harmony in the group -- this will also make your job as a trainer easier. Some of the most common distractions in a group are as follows:

A student is too talkative and tends to ramble. You, as the trainer, can interrupt with questions or comments in order to encourage more participation from others. You may also comment that the rambler's points may be interesting and then restate the most relevant points and move on to the next topic.

Side conversations between people. Although this is very distracting, the conversation may be related to your topic. Do not embarrass the people who are talking, but try to re-focus their attention to what is going on in the rest of the group.

Personality clash. If this presents a problem, play down areas of disagreement and draw attention to the objectives of the topic.

There may also be people who don't talk. They may, be bored, shy, or confused. Use your judgement in finding out the reason. Try to draw out an opinion or point of view without being too forceful or embarrassing a shy person.

A member of the group states a fact that is definitely wrong. Handle this situation carefully. You want him and the rest of the group to have the right information but you do not want to embarrass one person in front of others. One way to handle this situation is to ask the rest of the group for another point of view in hopes of getting the right answer without Putting him "on the spot."

The Physical Set-Up

A major part of being an instructor is the physical presentation of the material. The way you present demonstrations or audio-visual material has an affect on how well the trainees receive and remember information.

The following pointers should help you with your presentation:

1. Check the meeting room.

- Is it the right size, i.e. , not too small or too large for the size of your class?
- Are there enough desks or chairs with writing surfaces?
- Can you be heard by everyone wherever you decide to stand or sit?
- Is there a table you can Use for the classroom demonstration?
- Is a table available for the slide projector?
- Is there a screen or a blank wall that is suitable for showing slides?
- Is the outlet near the slide projector or is it necessary to use an extension cord?
- Can the windows be darkened for showing slides?

- Can the temperature of the room be controlled?
- Will you need a clock or a wristwatch so you can pace your presentation?

2. Classroom demonstrations.

- Check the planning notes to see what materials and equipment you will need.
- Make sure all the needed materials are available for the day you need them.
- If necessary, sign out the materials and double-check to make sure they will be there.
- Practice the demonstration to make sure the equipment works and to see how long it will take.

3. Using slides.

- Sign out the projector, slides, and screen for each day you will need them.
- If you don't know how to set up the equipment, have someone show you.
- Check the equipment to make sure it is in good working order. If necessary, clean the lens of the projector. Keep a spare light bulb available. Check the remote control devices, as well as the other controls, such as focus, forward, back-up. Make sure you know where the projector cords and plugs are kept.
- Be sure you are familiar with the slides for each topic. Read through the material so you'll know what is going to be illustrated.
- If the slides jam as you are using them, do not force the machine. Turn off the bulb and carefully work the slide out. You may have to remove the carousel or magazine.

When you are finished with the presentation, replace the slides in the appropriate box and pack the projector in its case. Return the equipment in the same condition you would like to receive it.

Using the Instructor's Manual

The instructor's manual is a guide to help you in your classroom presentations. It is organized into three major learning areas: Marine Coating Technology (Part A), Surface Preparation: The Key to Coating Performance (Part B), and Paint Application: Techniques and Practices (Part C). Each of these

learning areas is then divided into units. Each unit contains related topics of discussion. Look at the topic titles before your presentation so you will know the main points of each unit.

Each unit also contains a set of slides, planning notes, and a quiz for the trainees. The slides correspond to the text material. Refer to the planning notes for the proper set. In each unit, the planning notes also state the learning objectives, the key terms, and the directions and answers to the quiz.

Once the entire unit has been covered, the trainees should take the quiz. Emphasize that this is part of the learning process. Always review the correct answers with the trainees to reinforce what you have taught them. Be prepared to explain the right answers. The trainees can mark their own papers or you may keep them to evaluate their progress in the program.



The instructor's manual is designed to be a helpful guide in the preparation and presentation of the text material. As you become more familiar with the program, you will find that it is flexible and allows for individual modification. As a paint department supervisor, it is your job to ensure quality coating work while maintaining productivity and developing the skills of your operators. Your involvement in the development of painting skills as well as cost awareness in your department will provide competitive advantages and increased profits.

Questions

20 QUESTIONS ON SUPERVISORY COMMUNICATION

Agree Disagre

- | | | | |
|-------|-------|-----|--|
| [] | [] | 1. | A good definition of communication is the sending of information from one person to another. |
| [] | [] | 2. | The best way to get the feedback of the workers is to ask, "Does anyone have any questions?" |
| [] | [] | 3. | When a change is introduced, it is important to listen to the questions and comments of the crew. |
| [] | [] | 4. | Workers will better understand communication or instructions from the supervisor if they are asked for their own ideas and comments. |
| [] | [] | 5. | A supervisor has failed to communicate instructions properly unless his crew understands the message the way the supervisor intended it. |
| [] | [] | 6. | A good supervisor spends more time listening than in any other form of communication. |
| [] | [] | 7. | The first-line supervisor or foreman is the key person in effective employee communication. |
| [] | [] | 8. | If the supervisor knows the work procedures well, he is therefore able to communicate it or teach it to his crew. |
| [] | [] | 9. | Being an effective communicator is a necessary qualification for a successful supervisor. |
| [] | [] | 10. | To be sure that the crew understands the instructions of the supervisor, it is best that they repeat it to him in their own words. |
| [] | [] | 11. | Most workers would be interested in knowing more" about the ships they are working on and how their work relates to the final product. |
| [] | [] | 12. | The supervisor's use of effective visual aids usually increases the workers' understanding significantly. |
| [] | [] | 13. | Most people can listen approximately four times as fast as they usually speak. |

(continued)

Agree Disagree

- | | | | |
|-----|-----|-----|---|
| { } | { } | 14. | The use of a relevant example is a very good way to make the communication clear. |
| { } | { } | 15. | A supervisor has failed to communicate effectively unless the workers understand, accept, and carry out the instructions. |
| { } | { } | 16. | The information that management wants to pass on to a new worker is usually the same information that the new person wants to know. |
| { } | { } | 17. | Nearly all workers want to know what their supervisor thinks of their work and appreciate a constructive evaluation. |
| { } | { } | 18. | In getting the workers to listen, the subject matter is more important than the way in which the subject is presented. |
| { } | { } | 19. | A logical explanation by management will not be accepted if it ignores the personal feelings of the workers. |
| { } | { } | 20. | Silence on the part of the workers usually indicates their understanding and acceptance of the instructions. |

1. This definition assumes that the listener will get the message and will read or listen to it and will understand it. A better definition can be found in Question No. 5 which states that the speaker has not communicated unless the listener understands.
2. The worker may not ask questions for several reasons: (1) He does not want to appear "stupid," (2) He thinks he understands, or (3) He is afraid that he may embarrass himself by showing how little he knows. A better way to get feedback is to promote discussion by asking the workers to relate this to their own work.
3. Whenever a change is introduced, it is important to allow people to raise questions and to complain about the change. By listening, management will not only allow employees to get their feelings expressed, but they also may pick up some ideas and suggestions on the implementation of the change.
4. Most people have felt about another person as follows: "If he doesn't listen to me, then I won't listen to him." If the supervisor is interested and willing to listen to the ideas of the crew, the crew will probably be more motivated to listen to ideas and instructions from the supervisor. Better rapport will have been established which will eliminate many communication barriers.
5. This improves upon the definition of communication discussed in Question No. 1.
6. Recent research showed that supervisors do spend more of their time listening than they do in reading, speaking, or in writing.
7. The first-line supervisor is the one who communicates directly with the production workers. Therefore, he is the most important person in effective company communication because the impact of his inability to communicate will probably be the greatest.
8. There are many people in universities, high schools, and in business and industry who have a thorough knowledge of the subject but are very poor at communicating it. Even with many years of experience in a field, subject knowledge is not related to ability and skill in communication.
9. A successful supervisor must be effective at communication in order to get his instructions across to his crew as well as communicate with other departments and his supervisor.
10. If we are the listeners, and we are not sure whether or not we understand a message, the best thing to do is to repeat it to the speaker, preferably in our own words. This feedback will tell the speaker whether or not we understand and he can always repeat it or say it in a different way to be sure that we do understand his meaning.

11. Most employees at every level would like to know about the work in progress. It makes them feel important and that they "belong" to the organization to see how their own work contributes to the final product.
12. Most of what we learn comes from a variety of the senses. Seeing as well as hearing reinforces the message. Therefore, the speaker who uses effective visual aids is usually more effective in getting the message across so that the audience understands it.
13. Research has shown that most people can listen from 500 to 1000 words per minute. Most of us speak from 125 to 200 words per minute.
14. The use of an example or illustration can often assist in the listener's understanding, by clarifying the meaning and helping the listener to visualize the subject matter.
15. Referring back to Question No. 5, a speaker or supervisor has communicated when his crew understands the message the way it was intended and carries out the instructions. The key word here is "communicate." Obviously, the supervisor has failed to do so unless the crew understands, accepts, and carries out the instructions. However, the worker may very well understand but still does not accept it, and therefore does not carry out the instructions as they were intended. This becomes a problem of motivation and follow-up rather than communication. It is important to discover whether the problem is one of communication, motivation, lack of time, etc.
16. A typical new employee is usually interested in what the company will do for him in terms of vacation, rewards, opportunity for advancement, security, etc. Management is also interested in telling an employee what they expect from him in performing his job and so on. An induction program should include both aspects of the job.
17. It is basic to a feeling of job security that an employee knows how he stands. If he is doing an outstanding job, obviously he wants his supervisor to communicate this to him. If the work is not satisfactory as the supervisor sees it, he wants to know this also so that he can do something about it. Most employees realize that the supervisor is the key person in their rewards and security with the company. Therefore, they want to know how they stand with him.
18. It is an unfortunate truth that most people are more motivated to listen because of the manner in which material is presented rather than the subject content itself. In maintaining the interest of the audience, most speakers have to "sell" their subject matter by effective presentation.
19. Most people are influenced more by personal feelings and emotions than they are by logical explanations. If employees have strong personal feelings toward management or toward what they are trying to do, this will greatly influence their willingness to listen and accept information, no matter how logical and factual it is.

20. Silence on the part of the crew can indicate many things including the fact that they understand and accept the communication. Silence can also mean that someone has been daydreaming, does not fully understand what has been communicated, or does not agree with what has been said.

HOLDING PRODUCTIVE TRAINING MEETINGS

Circle your preferred response. (A = Agree; D = Disagree)

- | | | |
|---|---|---|
| 1. A meeting is the best way to train people and develop their skills. | A | D |
| 2 A meeting is productive if the group leader's objective is accomplished. | A | D |
| 3. Most of the causes of nonproductive meetings are under the direct control of the leader. | A | D |
| 4. Many causes of nonproductive meetings can be avoided with good planning and preparation. | A | D |
| 5. The preparation time of the leader should be at least twice as long as the meeting itself. | A | D |
| 6. Physical facilities are important to the success of the meeting. | A | D |
| 7. A chalkboard, flip chart, and/or slide projector should be standard equipment for every meeting. | A | D |
| 8. If the leader has properly planned for physical facilities and equipment, there is no reason to check on them just prior to the meeting. | A | D |
| 9. Visual aids are necessary for effective presentations. | A | D |
| 10. The poorer the speaker, the more helpful visual aids become. | A | D |
| 11. Examples and humor always improve the effectiveness of a presentation. | A | D |
| 12. An effective leader must be able to ask clear questions that participants can answer. | A | D |
| 13. An effective leader must be able to answer all questions that are asked by the participants. | A | D |
| 14. If a participant asks a question, it should be turned back to the group for an answer. | A | D |
| 15. If initial enthusiasm can be obtained from the participants, it will be maintained throughout a meeting. | A | D |
| 16. Fear of being embarrassed or ridiculed by the leader is a frequent cause of non-participation. | A | D |

(continued)

HOLDING PRODUCTIVE
TRAINING MEETINGS

Page 2

- | | | |
|---|---|---|
| 17. Participants should leave a meeting thinking "I'm glad I came." | A | D |
| 18. A leader should start the meeting on time even if some of the participants aren't there. | A | D |
| 19. If a participant is causing problems for the leader, the leader should handle the situation without embarrassing or ridiculing the participant. | A | D |
| 20. Careful selection should be made in selecting a speaker or conference leader for a meeting. | A | D |
| 21. If a leader is carefully selected, a minimum of orientation is needed to acquaint the speaker with the objectives and the participants. | A | D |
| 22. A leader can always tell whether or not a meeting is productive. | A | D |
| 23. Participants can always tell whether or not a meeting has been productive. | A | D |
| 24. Meetings can change attitudes as well as teach knowledge and skill. | A | D |
| 25. Quizzes can be used to improve the effectiveness of training meetings. | A | D |
| 26. After each meeting, the leader should use some method to evaluate the meeting. | A | D |

QUALITIES OF A GOOD GROUP LEADER

- Knowledge of subject
- Knowledge of participants
- Desire to conduct meetings
- Willing and able to spend time to prepare
- Ability to make ideas understood
- Ability to initiate and control discussions
- Sincerely interested in ideas of participants
- Patient
- Tactful
- Listening skill
- Respected by the participants

PREPARING FOR EACH TRAINING SESSION

CHECKLIST

A Few Days Before

- 1 Check whether the audience has been notified of the training session, especially the exact time and location.
- 1 Check sequence of topics before the session (message should be logical and flow smoothly); maintain continuity.
- . Check accuracy of visual materials before the session; be sure no incorrect or misleading information is used.
- . Check whether handout materials have been prepared and assembled in the proper order; decide whether the audience should receive handouts prior to the session.
- . Practice a discussion of the topics in advance (if possible, practice in the presence of someone in the room you will be using).

On the Day of the Session

- . Check room set-up and seating arrangement; make sure enough chairs are provided.
- 1 Check lighting, heating, and ventilation; try to ensure the physical comfort of your audience.
- . Make sure clean ash trays and water glasses are provided, if appropriate.
- 1 Check location of telephones, rest rooms, and vending machines.
- . Check whether all required equipment and aids are in the proper place for use when needed.
- 1 Check the condition of all required equipment and aids; see that they are in good working order.

HOW TO USE A CHALKBOARD

CHECKLIST





- . Keep the chalkboard clean.
- . Erase all unrelated material.
- . Have erasers and extra chalk readily available.
- . Break chalk in half if it squeaks.
- . Check lighting; try to avoid glare.
- . Present material simply, briefly, and concisely; limit writing to key phrases; think in terms of restraint, not excess.
- . Write legibly and neatly (letters should usually be about three inches high).
- . Leave sufficient space between lines.
- . Use colored chalk for emphasis.
- . Underline words for emphasis.
- . Draw difficult diagrams beforehand.
- . Use a pointer to direct attention to major points.
- . Continue to talk while writing, if appropriate; maintain audience contact.
- . Place the chalk on the tray when you have finished writing; avoid playing with the chalk.
- . Allow time for the audience to read, study, and Copy the developed material.
- . Stand to the side of the material being presented; remove all obstructions.

HINTS ON THE ART OF QUESTIONING

- Try to get volunteers to speak up. Some people are embarrassed if they are called on. If you must direct a question to an individual, call the person by name and then state the question. It gives him a chance and it is a courteous gesture. Direct questions should be asked as infrequently as possible.
- . After asking a question, give the group members a chance to think. You might write it on the board while they are thinking. If there is no response, you may say "Mr. Paul, you have had 15 years of experience in the paint department -- may we have your opinion?"
- . Listen carefully to the answers given by the group members; be sincerely interested in what they have to say.
- . Be sure the same few people don't answer all the questions. Try to encourage all members of the group to express their individual opinions.
- . Prepare questions that require some thinking and which may stimulate a discussion. The purpose of the questions is to reinforce important material, not to trick the group members.
- . Questions that produce a "yes" or "no" answer should, if used at all be followed by asking the group member his reason for such an answer. WHAT, WHY, WHEN, WHERE, WHO, WHICH and HOW questions cannot be answered by "yes" or "no." Encourage complete and clearly stated answers.




Controlling a Meeting

WORKING WITH MEN AND WOMEN IN MEETINGS

HOW HE/SHE ACTS	WHY	WHAT TO DO
 <p>Overly Talkative</p>	<p>He/she may be an "eager beaver" or a show-off. He/she may also be exceptionally well informed and anxious to show it, or just naturally wordy.</p>	<p>Don't be embarrassing or sarcastic . . . you may need their traits later on.</p> <p>Slow them down with some difficult questions.</p> <p>interrupt with: "That's an interesting point. . . now let's see what the group thinks of it."</p> <p>In general, let the group take care of them as much as possible.</p>
 <p>Side Conversation</p>	<p>May be related to the subject.</p> <p>May be personal.</p> <p>Distracts members and you.</p>	<p>Don't embarrass them.</p> <p>Call one by name, ask an easy question</p> <p>Call one by name, then restate last opinion expressed or last remark made by group, and ask his/her opinion of it.</p> <p>If, during conference, you are in habit of moving around the room, saunter over and stand casually behind members who are talking. This should not be made obvious to group.</p>
 <p>Inarticulate</p>	<p>Lacks ability to put thoughts in proper words..</p> <p>He/she is getting idea but can't convey it.</p> <p>He/she needs help.</p>	<p>Don't say, "What you mean is this." Say, "Let me repeat that" (then put it in better language).</p> <p>Twist their ideas as little as possible, but have them make sense.</p>
 <p>Definitely Wrong</p>	<p>Member comes up with comment that is obviously incorrect.</p>	<p>Say, "I can see how you feel" or "That's one way of looking at it."</p> <p>Say, "I see your point, but can we reconcile that with the (true situation)?"</p> <p>Must be handled delicately.</p>

Business Meetings

WORKING WITH MEN AND WOMEN IN MEETINGS

HOW HE/SHE ACTS	WHY	WHAT TO DO
 <p>Rambler</p>	<p>Talks about everything except subject.</p> <p>Uses farfetched analogies, gets lost.</p>	<p>When member stops for breath, thank him/her, refocus attention by restating the relevant points, and move on.</p> <p>Grin, tell him his/her point is interesting, point to blackboard and in friendly manner indicate we are a bit off subject.</p> <p>Last resort: glance at watch.</p>
 <p>Personality Clash</p>	<p>Two or more members clash.</p> <p>Can divide your group into factions.</p>	<p>Emphasize points of agreement, minimize points of disagreement, (if possible).</p> <p>Draw attention to objectives. Cut across with direct question on topic.</p> <p>Bring a sound member into the discussion.</p> <p>Frankly ask that personalities be omitted.</p>
 <p>Obstinate</p>	<p>iVon't budge!</p> <p>Prejudiced.</p> <p>Hasn't seen your points.</p>	<p>Throw the member's view to group, have group members straighten him/her out.</p> <p>Say that time is short, you'll be glad to discuss it later; ask member to accept the group viewpoint for the moment.</p>
 <p>Won't Talk</p>	<p>Bored.</p> <p>indifferent.</p> <p>Feels superior.</p> <p>Timid.</p> <p>InSecure.</p>	<p>Your action will depend upon what is motivating the member.</p> <p>Arouse interest by asking for his/her opinion.</p> <p>Draw out the person next to him/her, then ask the quiet lad to tell the fellow next to him what he thinks of the view expressed. If he is seated near you, ask his opinion so that he'll feel he is talking to you, not the group.</p> <p>If member is the "superior" type, ask for view after indicating the respect held for experience. (Don't overdo this. Group will resent it.)</p>

Kirkpatrick, Donald L., How to Plan and Conduct Productive Business Meetings Dartnell Corp., 4660 Ravenswood Ave., Chicago, IL 60640, 1976.

THE POWER OF EXAMPLE

ing, always remember the tremendous importance of your personal example. A good supervisor teaches as much by example as by precept, or if you teach your workers to use one method, and you use another yourself, you will find it difficult to get the workers to follow you. Your actions must square up with your words. What you do must be the same as what you say.

A supervisor tries to put himself in the position of the new worker; he gives his instructions from those facts which the worker knows, he does not hastily proceed to new material which the worker is not familiar with.

"Where the worker is; lead up to where you want him to be." This rule is obvious, but it is often overlooked by a supervisor who is so familiar with the material that he does not take time to distinguish between what is simple to a new worker and what might seem complicated.

When workers learn new ideas and skills, a supervisor can compare new examples to unfamiliar material. A good teacher can describe a new example so clearly that others actually feel as if they have seen it. For example, it isn't necessary to get burned to learn that fire is hot. In giving safety instructions, it is much better to make workers imagine possible accidents and to prevent their actual occurrence.

When dealing with technical or numerical data, the point is made much clearer by relating a familiar visual idea to a general idea. For example, when you describe the thickness of a coat of paint, the term "one mil," or "1/1000 inch" is not completely understood by everyone. But if a comparison is made with a familiar, imaginable object, such as 1/3 the thickness of a strand of hair, it becomes an easily visualized image. Furthermore, such an example is more likely to be remembered. Following are other examples which you can use in the training sessions.

Example 1: Describe the approximate thickness of a piece of cellophane.

Example 2: Describe the weight of abrasive materials would fill a convoy of about 16 Army trucks (2 1/2 tons each).

Example 3: Describe the speed at which paint is sprayed from an airless gun (up to 450 mph) compared to the 1963 racecar record of 407.45 mph.

Example 4: Describe the weight of a 1 mil thick diamond coating would require approximately 1/1000 of a pound of paint.

11 STEPS TOWARD IMPLEMENTING A TRAINING PROGRAM IN YOUR YARD

1. PHYSICAL FACILITIES can aid in the effectiveness of a program. A comfortable and well-equipped training site is a tangible illustration of the importance management places on the program.
 - Good facilities cannot make up for a poor program, but a good program can lose its effectiveness if participants are uncomfortable.
 - Provide the best possible conference-type surroundings.
 - Make certain that:
 - the ventilation and lighting are good,
 - the room size is appropriate for the group, and
 - the desks and chairs face the chalkboard and screen.
2. OFF-THE JOB CONCEPT. The participants' ease in learning increases in a training site that is away from the primary work area. A training program removed from the daily work environment aids in the receptiveness of participants and makes learning easier because it:
 - reduces the possibility of interruptions and
 - reduces daily job pressures.
3. SCHEDULE. Careful scheduling will contribute to the success of a program.
 - Consider your company's past practices for scheduling similar programs, or the training scheduled for other trades.
 - Consider Union rules on work time and training.
 - Take into consideration the attitudes of the supervisors who will be involved. If they feel attending the program after hours is an imposition on their own time, check your company's policy on compensation and incentives.
 - If management agrees, schedule the program during the workday. Held on company time, a program shows it has management's commitment. One workable arrangement may be to hold the program on both company and private time, requiring a commitment to training and skills development from the yard and the supervisors.
4. LENGTH OF SESSIONS. Determine the amount of time you will need to cover each learning unit in the Instructor's Manual. This will vary according to:
 - the participants' level and experience,
 - the amount of material in each unit, and
 - the use of demonstrations in the field.

1 Decide if the total program will be "spaced" or "continuous" training sessions that take place over a period of time. A typical example is a one-hour session each week, reinforced with on-the-job training in between.

1 A continuous program covers all the units on consecutive days. Operators and supervisors who are not used to sitting at a desk will want a break every 60-75 minutes.

The degree to which on-the-job training is necessary, as well as other considerations, will help to determine how you schedule your program. A typical schedule for training operators would be two one-hour sessions each week with on-the-job training to reinforce what was covered in class. If your goal is to update the knowledge of supervisors, a 3-4 day program would be suitable.

5. SELECTION OF SUPERVISORS AS TRAINERS. This program has been designed to help yard supervisors to train and develop their painters and blasters. You must determine which supervisors will participate in the program.

1 Will you train all supervisors, or only those who need training the most?

1 What are the training objectives in your yard?

- Upgrading the supervisors' knowledge of painting.
Teaching them to improve the skills of their paint crew.
- Preparation for classroom situations.

It is recommended that all supervisors participate in the training program. They will gain knowledge, personal development, and add training to their leadership skills. By having all your supervisors participate in the program, you will not have to "single out" individuals to attend. Furthermore, the better, more skilled supervisors will be able to assist those who may be less experienced.

In choosing supervisors who will act as trainers, consider these qualifications:

- 1 knowledge of subject matter
- 1 good attitude toward teaching, toward the trainees, and toward preparing for the sessions
- 1 skills in presenting information
- 1 skills in leading discussions and asking questions
- 1 tact, patience, open-mindedness
- 1 respect of the participants

6. PROGRAM CONTENT should match the needs in your yard. Adapt the Instructor's Manual to the practices and procedures in your yard. In addition to discussing the technical information, in a complete program you should also:

- 1 state the objectives clearly,

- establish the supervisor's role in the development of his crew,
- review your yard's policies for induction and orientation of new hires:
create an orientation checklist
- establish the training objectives for the operators:
 - define the required skills,
 - identify the "need to know" areas,
 - provide information based on your yard's practices, equipment, and work load.

7. MANAGEMENT RECOGNITION. Management's support of your program establishes the importance of training with the participants. Illustrate this support and backing:

- Recommend that the President write a letter to the supervisors, stating the value of the program.
- Invite the President or Vice President of Production to welcome the group on the first day of the program.
- Ask management personnel to speak at a banquet meal to discuss and reinforce the benefits of the program.
- Present program awards or certificates for satisfactory program participation.
- Use different levels of management to reinforce the major themes of the program. People to consider as speakers are the
 - President, for his interest and support in the program.
 - Vice President of Operations or Production to discuss the effect of training on production.
 - Q.A. Manager or Engineer to reinforce the role of painting in corrosion control.
 - Personnel Officer for the relationship of training to hiring policies and career advancement.

8. ACTION LOG. Keep a record of what happens during the program. This kind of record, or log, will be valuable for setting up future programs.

- Take accurate notes of all suggestions, criticism, and solutions to problems.
- Use this record for:
 - follow-up programs,
 - tracking tangible results, and
 - selected management reporting.

9. FINAL EVALUATION of the entire program should be made by the participants at the last session. Create an evaluation form to be returned to you. The elements to be evaluated should include:

- the level of the program content. Was it appropriate for the participants? Was it too theoretical, or too elementary? Was new information provided that will be practical on the job?
- the delivery of the trainer's presentation. Was the trainer easily heard and understood? Were questions answered in an open-minded way? Was the session kept interesting?
- the organization of the hands-on demonstrations.
- the appropriateness of the scheduling and timing.
- the use of films, slides, and other visuals.
- the value received from the program. Did the program accomplish its stated goals?

Encourage participants to make suggestions or recommendations on their own.
(If the forms are anonymous, they may reveal more candid responses.)

10. FOLLOW-UP activities are important for both the trainees' benefit and for establishing future programs. Training is continuing education, not just an isolated incident. A follow-up program reinforces previously learned material and allows for the presentation of new ideas and information. To put a follow-up program into action:

- establish review meetings to assist supervisors in the training programs they will set up;
- take a survey of their needs for further self-development;
- organize a supervisors' "club" or lunch sessions to exchange ideas on improving operator training;
- plan for problem solving sessions or presentations on new products, procedures, and equipment.

11. CLIMATE ON THE JOB. After a training program has been established, the everyday work environment can either reinforce or destroy what has been learned. Acceptance back in the yard makes the difference. Which climate will your yard have?

- A PREVENTIVE CLIMATE is one in which there is only one way to do things -- the way the boss wants them done. Unless his way is the same as the training program, anything new is considered out of place and will not be accepted in the actual work situation. This is discouraging for those who have the ability and the desire to learn and develop their skills. This climate opposes the goals of training.
- In a NEUTRAL CLIMATE the ends justify the means. The primary interest here is output. The boss is not opposed to learning and using new techniques or to sticking with old ones, as long as the production goal is achieved. He does not care if you do the job his way or not, just as long as it gets done on time. New skills are accepted in this climate, as are old ways, just as long as there is demonstrated output. It is up to the individual to apply his new information to the job -- there is no incentive from the boss to improve.

- In a REQUIRING CLIMATE, the boss is curious to see what has been learned in a training program and how it can help the daily work. In this situation, increased knowledge and field skills are reinforced when trainees are encouraged to use what they have learned. The value of training is clear in this kind of supportive climate.

Training will not solve every problem encountered on the job, but it does develop skills in preventing and solving problems. In a situation where supervisors show their approval and support of training, a successful program will not end in the classroom or at the demonstration site, but will continue for a long time in the yard

MAKING THIS PROGRAM WORK FOR YOU



Get to Know This Manual.

Look over the Table of Contents and the Unit headings to become familiar with the scope of the material covered and how it is organized. Get an overview of the manual by skimming it from cover to cover.

Scan the References Found in the Appendix.

These pages contain valuable information on booklets, movies, and manufacturing companies or professional organizations which can provide you with supplemental materials to use in your training program. You can write away for these, many of which are available at no charge.

Carefully Read the Instructor's Guide.

As a supervisor directing your crew, you are teaching everyday without necessarily being aware of it. Organizing a training session will use these same skills, but it will require some careful thought and advance planning. The Instructor's Guide (found toward the end of the manual) will help you to organize a training program.

The Guide contains helpful tips on:

- keeping group interest,
- using slides properly,
- keeping control of the group,
- the art of questioning,
- the qualities of a good group leader,
- using a chalkboard effectively, and
- the power of example to improve your discussions.

Review the Checklist.

Refer to the checklist, "Implementing a Training Program in Your Yard," found in the Instructor's Guide. Eleven important steps for setting up a program are outlined and explained. Use them to develop an action plan.

Create a Schedule.

- A. *IDENTIFY* the people who will be trained. Will the program train all new painters or experienced painters? Will leadmen and foremen be included?

If your yard is large enough, will you train mid-level supervisors so they can help to improve the skills of their crews?

Determine who the participants will be based on the training needs of your department. You may wish to implement a skills measurement test, for example, and begin by training those who score below a minimum grade.

- B. CHOOSE the topics you will cover in your training program. Go back over the three Parts of the manual and decide which units are most suitable for your group. For new painters, you will want to cover all the topics, as well as add supplemental materials whenever you can. If your purpose is to update or improve the skills of experienced painters, you can select the individual units that are most needed.
- c. DECIDE how much time will be needed for painter training.
 - The actual amount of classroom time for each unit depends on the group. For new painters, you will have to cover more details, since all of the material is new to them. Experienced painters will have questions, based on their own work, which can lead to lengthy discussions.
 - Each classroom session should be limited to one hour. Concentration falls off if sessions are too long.
 - Some units involve demonstrations. Allow sufficient time to set up the site and the equipment. Plan enough time for each participant to practice using the equipment and to ask questions.
- D. DETERMINE the location and time of day to hold the training program. Clear this schedule with all of the supervisors whose painters will be involved. Confirm the schedule with all management personnel who will be effected:
 - paint department superintendent,
 - materials warehouse manager,
 - meeting room coordinator,
 - personnel department, and
 - other office and management personnel.
- E. ANNOUNCE the training program to the appropriate supervisors.
 1. State specifically:
 - the purpose of the program,
 - the time,
 - the location, and
 - the number and type of individuals who should attend.
 2. Request from the supervisors:
 - the names of the individuals who will attend and
 - participant background information related to their knowledge and skills.
(You may devise a simple form to be filled out and returned to you.)



Plan the Overall Program.

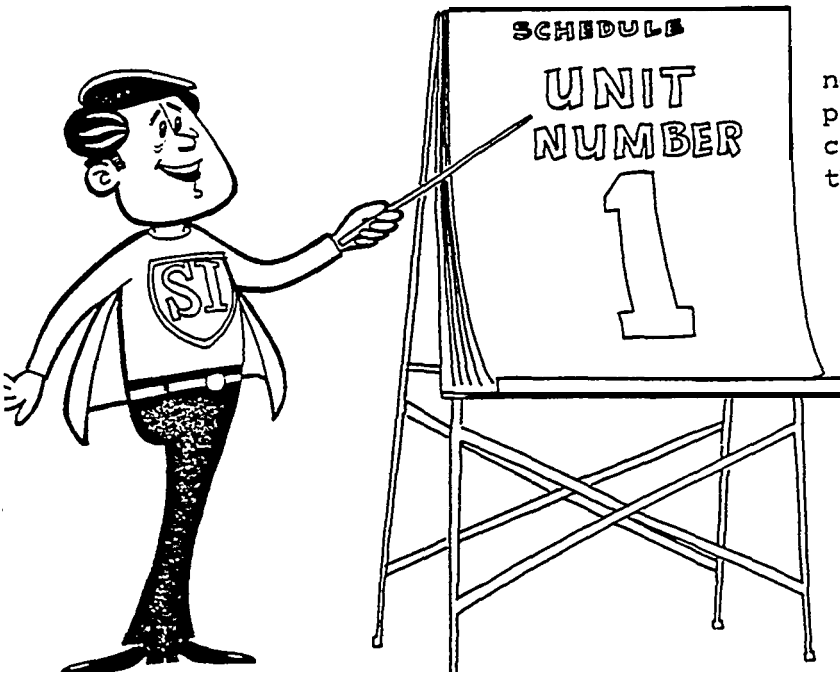
- A. SELECT specialists to help you teach particular topics. You can get help from:
 - paint manufacturer's reps, shipyard safety specialists,
 - engineers or design specialists,
 - equipment reps, and inspectors.
- B. REVIEW the units for demonstrations. Coordinate and confirm the use of the necessary materials and equipment. Make field-arrangements with the appropriate personnel well in advance.
- C. REQUEST additional materials. Write away for movies, charts, booklets, and other materials 6 to 8 weeks in advance of the training program to make sure they are available for the scheduled day.
- D. PREPARE your own handouts:
 - diagrams of equipment used in your yard, slides from your own collection, or
 - equipment or safety procedures used in your yard.

Get Ready for the First Training Session.

Use the checklist: "Preparing for Each Training Session." (It is found in the Instructor's Guide.) This will help you to keep track of the arrangements.

You may have a case of stage-fright if you have never taught a group before. This is to be expected. Even the most experienced speakers often feel this way in front of an audience. However, you will become more comfortable with your new role if you take the time to PLAN and PRACTICE. The more you practice, the more confident and at ease you will become. The more confident you are, the better job you will do. Taking the time to read and study on your own will also help you to develop your professional and personal growth.

Although you must be credible with the participants, you are not expected to answer every question that may be asked in the classroom. However, you will maintain the respect of the group if you say honestly, "I don't know, but I can find out for you." Remember that many kinds of skilled professionals are required to design, construct, and maintain a ship. You are a specialist in the paint department and you perform your job well. You, your supervisors, and painters are not expected to have the skills of other specialists and they do



not have your skills and knowledge of paint application. Make this point clear to the participants and encourage them to do the best job possible.

Presenting the First Training Session.

- A. INTRODUCE yourself and explain that this first session will combine get acquainted, establishing the goals of the training program, and the tol for that day.
- B. ASK each person to introduce himself, if there are new people who don't know each other. Ask each one to briefly identify what he expects from the course.
- C. DISCUSS the schedule. Make certain that everyone knows where and when each session is held. Is attendance mandatory? What will happen if a participant misses a session?
- D. EXPLAIN that quizzes will be given to test and reinforce their knowledge. Be specific in the way you plan to use the quizzes. Will the quizzes be given at the end of each session? How will they effect each participant's job, chance for promotion, or pay? Will the supervisors see the quiz results? Decide if a skills test will be given-in the field and how you will use the results.
- E. HAND OUT the student books. Explain what they"are and quickly review the contents. Each participant should feel free to underline and make notes in his own book. Explain that reading the book before coming to the session will be helpful, but it is not required for attendance." They will still learn during the session without having done advance readng.



- F. STATE THE GOALS, or the learning objectives, and a list of activities before discussing the topic for the day. This will help the participants to know what to expect that day. Begin each session this way.

Conclusion.

If you familiarize yourself with this program and follow the steps outlined above, you will go from being a "supervisor as instructor" to a *SUPER INSTRUCTOR*. In this role, you will communicate your knowledge and skills to others in an organized and systematic way. The participants will gain ideas and information that will help them on the job. As you teach them, you also continue to learn. Training will prove to be a valuable learning experience for you as well.



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